



Ultrium LTO 3 Tape Drive  
Tandberg Storage Solution 840LTO

Setup, Operator, and Service Guide

**Note**

Before using this guide and the product it supports, read the information in “Safety and Environmental Notices” on page ix and “Notices” on page 65.

**First Edition (December 2004)**

This edition applies to the *Ultrium LTO 3 Tape Drive Model Tandberg Storage Solution 840LTO Setup, Operator, and Service Guide* and to all subsequent releases and modifications until otherwise indicated in new editions.

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## Safety and Environmental Notices


When using this product, observe the danger and caution notices contained in this guide. The notices are accompanied by symbols that represent the severity of the safety condition.

The sections that follow define each type of safety notice.

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### Danger Notices






A danger notice calls attention to a situation that is potentially lethal or extremely hazardous to people.

	A lightning bolt symbol always accompanies a danger notice to represent a dangerous electrical condition.
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### Caution Notices

A caution notice calls attention to a situation that is potentially hazardous to people because of some existing condition. A caution notice can be accompanied by one of several symbols:

If the symbol is...	It means....
	A hazardous electrical condition with less severity than electrical danger.
	A generally hazardous condition not represented by other safety symbols.
 Class I	A hazardous condition due to the use of a laser in the product. Laser symbols are always accompanied by the classification of the laser as defined by the U. S. Department of Health and Human Services (for example, Class I, Class II, and so forth).
	A hazardous condition due to mechanical movement in or around the product.
 > 18 kg (40 lb)	A hazardous condition due to the weight of the unit. Weight symbols are accompanied by an approximation of the product's weight.

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## End of Life (EOL) Plan

This box is a purchased unit. Therefore, it is the sole responsibility of the purchaser to dispose of it in accordance with local laws and regulations at the time of disposal. This unit contains recyclable materials. The materials should be recycled where facilities are available and according to local regulations. In some areas Tandberg Data may provide a product take-back program that ensures proper handling of the product. Contact your sales representative for more information.

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## About This Guide

This guide includes information on setting up, operating and servicing the Ultrium LTO 3 Tape Drive in the following chapters:

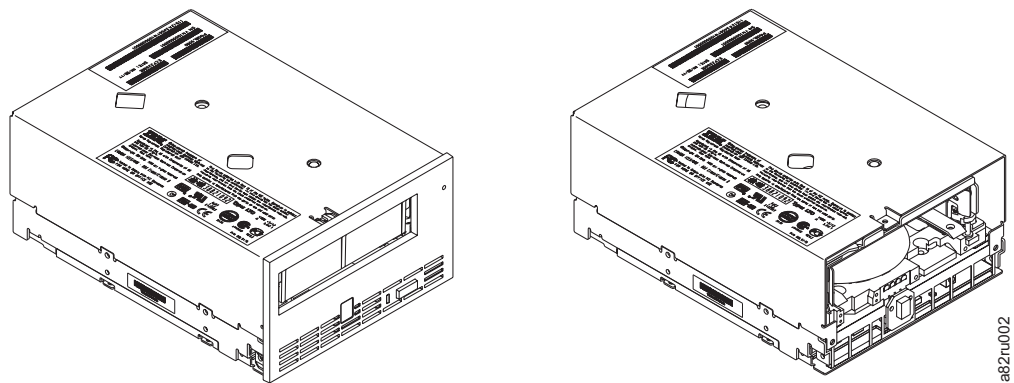
- “Product Description” on page 1 describes the drive, discusses supported servers, operating systems, and device drivers, and lists hardware specifications.
- “Installing the Drive” on page 9 tells how to unpack and set up the drive.
- “Operating the Drive” on page 17 describes the unload button, and status light on the drive. It explains the function of the message display and the single-character display. It tells how to insert and remove a tape cartridge, describes methods of updating drive firmware, and explains how to clean the drive. It also lists the diagnostic and maintenance functions that the drive can perform.
- “Using Ultrium Media” on page 37 describes the types of tape cartridges to use in the drive and defines the conditions for storing and shipping them. It also tells how to handle the cartridges, how to set a cartridge’s write-protect switch, and how to order additional cartridges.
- “Resolving Problems” on page 41 gives tips for solving problems with the drive and includes a flowchart that analyzes when the drive requires maintenance.
- “Servicing the Drive” on page 51 gives instructions on servicing the drive.



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## Product Description

The Ultrium LTO 3 Tape Drive is a high-performance, high-capacity data-storage device that is designed to backup and restore open systems applications. The drive can be integrated into an enclosure, such as a desktop unit, tape autoloader, or tape library. The drive is the third-generation in the Ultrium series of products. It is available as Model Tandberg Storage Solution 840LTO with a Small Computer Systems Interface (SCSI).



*Figure 1. View of the Ultrium LTO 3 Tape Drive with and without the bezel*

The drive offers the following features:

- Ultra160 Low Voltage Differential (LVD) Small Computer Systems Interface
- 68-pin, D-shell connector (for SCSI signals, SCSI ID selection, and power connection)
- Native storage capacity of 400 GB per cartridge (800 GB at 2:1 compression)
- Native data transfer rate of up to 80 MB per second
- Burst data transfer rate of 160 MB per second
- New dual stage 16 channel head activator for precision head alignment to help support higher track density with improved data integrity and backwards compatibility with previous LTO generations
- Graceful dynamic braking designed to maintain tension until the tape comes to a complete stop, to help prevent stretching or breaking the tape, and loose tape wraps
- Larger internal buffer (the size has been doubled over the Ultrium 2 to 128 MB)
- New independent tape loader and threader motors designed to help with cartridge insertion in the tape drive.
- Highly integrated electronics designed to reduced the total number of components in the drive, lower chip temperatures, and reduce power requirements, helping to provide for a more reliable drive. The Generation 3 drive electronics also incorporate on-the-fly error correction of soft errors in the memory arrays in data and control paths.

## Front Panel of the Drive

Figure 2 shows the front panel of the drive.

- |          |               |          |                                |
|----------|---------------|----------|--------------------------------|
| <b>1</b> | Status Light  | <b>3</b> | Single-character Display (SCD) |
| <b>2</b> | Unload Button | <b>4</b> | SCD Dot                        |

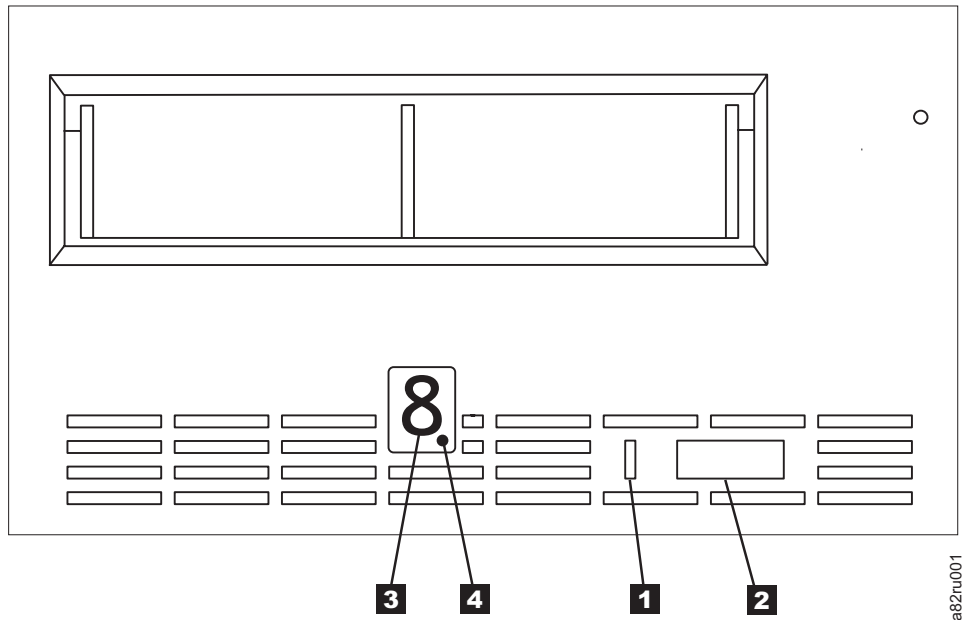


Figure 2. Front panel of the Ultrium LTO 3 Tape Drive

## Rear Panel of the SCSI Drive

- |          |                   |          |   |
|----------|-------------------|----------|---|
| <b>1</b> | SCSI connector    | <b>4</b> | Library/Drive Interface (LDI or RS-422 interface) connector |
| <b>2</b> | SCSI ID connector | <b>5</b> | Serial port   |
| <b>3</b> | Power connector   |          |   |

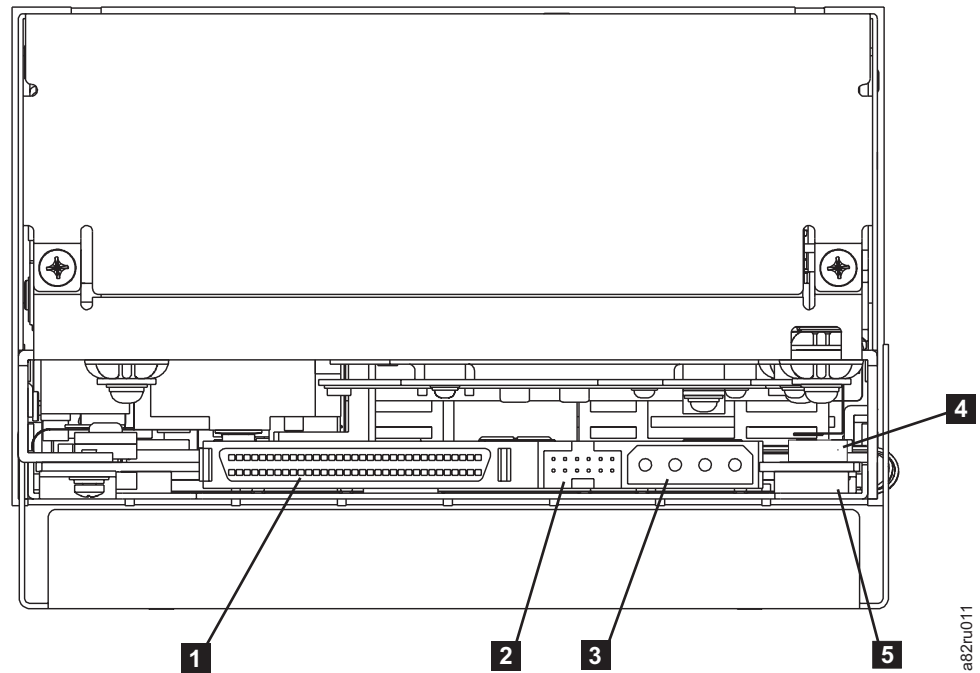


Figure 3. Rear panel of the Ultrium LTO 3 Tape Drive Model Tandberg Storage Solution 840LTO (SCSI drive)

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## Speed Matching and Channel Calibration

To improve system performance, the drive uses a technique called *speed matching* to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server. With speed matching, the drive operates at one of five speeds when reading or writing the Generation 3 cartridge format to achieve a native data rate of 40, 50, 60, 70, or 80 MB per second (MB/s). If the server's net (compressed) data rate is between two of the preceding native data rates, the drive calculates the appropriate data rate at which to operate. Speed matching dramatically reduces backhitch, the condition that occurs when a tape stops, reverses, and restarts motion. A backhitch is usually the result of a mismatch between the data rates of the server and the drive.

System performance is further optimized by a feature called *channel calibration*, in which the drive automatically customizes each read/write data channel to compensate for variations in such things as the recording channel's transfer function, the media, and characteristics of the drive head.

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## Sleep Mode

To conserve energy when circuit functions are not needed for drive operation, the drive features a power-management function that causes the drive's electronics to enter a low-power mode known as *sleep mode*. To enter sleep mode, the drive must be inactive for a minimum of 30 seconds (default value; this is programmable via the mode pages); to exit, the drive must receive a command across the SCSI interface, a command across the Library/Drive Interface (LDI or RS-422 interface), or a load or unload request. When in sleep mode, the drive's response time to commands that do not require media motion increases by up to ten microseconds. Commands that require media motion may be delayed an additional 100 milliseconds because the tape must be retensioned.



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## SCSI Attachment

To communicate with a server, the drive uses the Ultra160 LVD SCSI interface.

### Physical Characteristics of the SCSI Interface

The drive contains a high-density, 68-pin, D-shell receptacle connector (HD68) for attachment to the server. The HD68 connector includes the connectors for the SCSI signal, the SCSI ID, and the drive's power. The drive supports LVD SCSI cables with HD68 connectors.

### Speed

The Ultra160 LVD SCSI interface is compatible with older SCSI technology and is capable of data transmission at 160 MB/s. Ultra160 SCSI uses the three management features of the Ultra3 SCSI standard that specifically affect data transfer rate:

- **Double transition clocking** - a data-transfer technique that enables data rates to double without increasing clock speed
- **Domain validation** - a procedure that detects and adjusts SCSI configuration issues that might prevent interoperability between SCSI devices
- **Cyclic redundancy check (CRC)** - an error-checking technique

Because the cables, connectors, and terminators are the same for the Ultra160 and Ultra2 SCSI interfaces, devices with those interfaces can be mixed on the same bus and each device can operate at its fully rated speed.

## Specifications

### Physical Specifications

Specification	Measurement
Width	146.0 mm (5.75 in.) without bezel
	148.3 mm (5.84 in.) with bezel
Length	205.5 mm (8.09 in.) without bezel
	210.5 mm (8.29 in.) with bezel
Height	82.5 mm (3.25 in.) without bezel
	84.8 mm (3.34 in.) with bezel
Weight (without a cartridge)	3 kg (6 lb 10 oz)

### Power Specifications

Power Supply	5 V dc	12 V dc
Tolerance	10%	10%
Voltage Ripple/Noise (50 Hz - 20 MHz)	60 mV pp	125 mV pp
Minimum Supply Current (steady state)	1.3 A	0.2 A
Maximum Supply Current (steady state)	3.0 A	1.1 A
Peak Supply Current (instantaneous power by power supply)	3.3 A for 100 ms (15 W)	4.50 A for 2 ms (49.20 W)

Power Measurements	Ultra-160 SCSI drive
Idle Mode (no cartridge)	10W
Idle Mode (Cartridge loaded)	12W
Reading and Writing (@5.46 m/s)	28W

### Environmental Specifications

Environmental Factor	Operating (see Note 3)	Storage	Shipping
Drive temperature	10 to 40°C (50 to 104°F)	-40 to 60°C (-40 to 140°F)	-40 to 60°C (-40 to 140°F)
Relative humidity (noncondensing)	20 to 80%	10 to 90%	10 to 90%
Wet bulb temperature	26°C (78.8°F)	26°C (78.8°F)	26°C (78.8°F)
<b>Note:</b> Measured in front of the bezel, near the air intake area (refer to Figure 4 on page 10).			

## Other Specifications

Maximum altitude	3048 m (10,000 ft) for operating and storage
	12192 m (40,000 ft) for shipping
Extraction force	250 to 750 gms-force



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## Installing the Drive

### Attention:

To avoid static electricity damage when handling the drive, use the following precautions:

- Limit your movement. Movement can cause static electricity to build around you.
- Always handle the drive carefully. Never touch exposed circuitry.
- Prevent others from touching the drive.
- Before unpacking and installing the drive into an enclosure, touch its static-protective packaging to an unpainted metal surface on the enclosure for at least two seconds. This reduces static electricity in the packaging and your body.
- When possible, remove the drive from its static-protective packaging and install it directly into an enclosure without setting it down. When this is not possible, place the drive's packaging on a smooth, level surface and place the drive on the packaging.
- Do not place the drive on the cover of the enclosure or on any other metal surface.

The steps that follow describe how to install the drive into an enclosure.

**Note:** Depending on the type of enclosure, installation procedures may vary. Before starting this installation, read these instructions and compare them to the drive installation instructions for your enclosure.

---

## Installation Overview

- \_\_\_ 1. "Unpack the Drive" on page 10
- \_\_\_ 2. "Power Off the Enclosure" on page 10
- \_\_\_ 3. "Set the SCSI ID" on page 11
- \_\_\_ 4. "Mount the Drive into the Enclosure" on page 13
- \_\_\_ 5. "Connect and Test Power to the Drive" on page 14
- \_\_\_ 6. "Connect the Internal SCSI Cable" on page 14
- \_\_\_ 7. "Connect the Internal LDI Cable (optional)" on page 14
- \_\_\_ 8. "Run Drive Diagnostics" on page 15
- \_\_\_ 9. "Install Device Drivers" on page 15
- \_\_\_ 10. "Connect the Enclosure's External SCSI Interface to the Server" on page 15
- \_\_\_ 11. "Connect the External LDI Interface to the Server (optional)" on page 15
- \_\_\_ 12. "Configure the Drive to the Server, Switch, or Hub" on page 15

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## Unpack the Drive

Unpack the drive and store the packaging for future moves or shipping.

### Attention:

Acclimation time is required if the temperature of the drive when unpacked is different than the temperature of its operating environment (measured at the front of the bezel near the air intake area as shown in Figure 4). The recommended acclimation time is four hours after the drive has been unpacked or one hour after any condensation that you can see has evaporated, whichever is greater. When acclimating the drive, apply the following measures:

- If the drive is colder than its operating environment and the air contains sufficient humidity, condensation may occur in the drive and damage it. When the drive has warmed to the operating temperature range (greater than 10°C or 50°F) and no danger of condensation is present (the air is dry), warm the drive more quickly by powering it on for 30 minutes. Use a diagnostic tape to test the drive before inserting a tape that contains data.
- If the drive is hotter than its operating environment, the tape can stick to the drive head. When the drive has cooled to the operating temperature range (less than 40°C or 104°F), cool the drive more quickly by applying airflow for 30 minutes. Power-on the drive and use a diagnostic tape to test it before inserting a tape that contains data.

If you are uncertain about whether the temperature of the drive is within the recommended operating range or the humidity is sufficient to cause condensation, acclimate the drive for the full four hours.

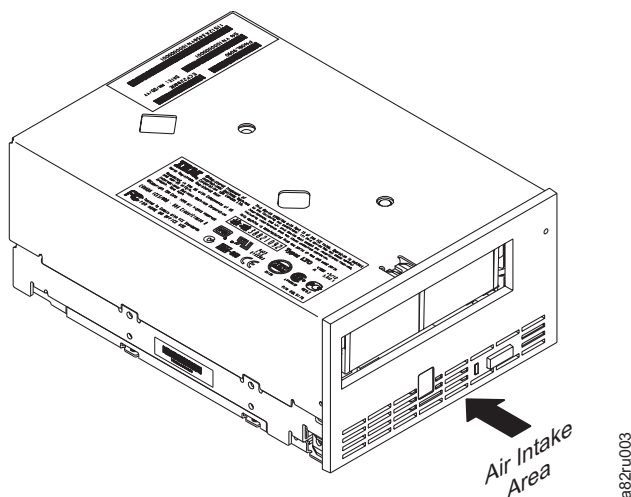


Figure 4. Temperature of the drive is taken near the air intake area

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## Power Off the Enclosure

1. Power-off the enclosure (or the unit that provides power to the drive)
2. Disconnect the power cord from both the electrical outlet and the enclosure.

## Set the SCSI ID

The SCSI ID can be set in one of three ways:

- By placing jumpers on the SCSI ID connector
- By using a SCSI ID switch that is connected to the SCSI ID connector
- By issuing a command from the library to set the SCSI ID through the drive's LDI interface

### Setting the SCSI ID with Jumpers

The SCSI ID can be set on the drive by installing 2 mm jumpers on the drive's SCSI ID connector (see **2** in Figure 3 on page 3). Your drive may come set to a default SCSI configuration, with jumpers already installed. To change the default SCSI configuration, contact your sales or technical support representative. You can change the SCSI ID by rearranging, adding, or removing jumpers.

#### To set the SCSI ID:

1. Locate the SCSI ID connector (see **2** in Figure 3 on page 3).
2. Before attaching the SCSI bus cable to the server, determine the SCSI ID. Make sure that the ID is not being used by another device.
3. Referring to Figure 5, find the ID number that you chose then place jumpers on the connector pins as shown (use a pair of needle-nose pliers to connect the jumpers to the pins that are shaded).

**Note:** If you set the SCSI ID to 15, the drive will not necessarily be set to that ID; instead, the drive will expect to receive the SCSI ID through a command over its LDI interface.

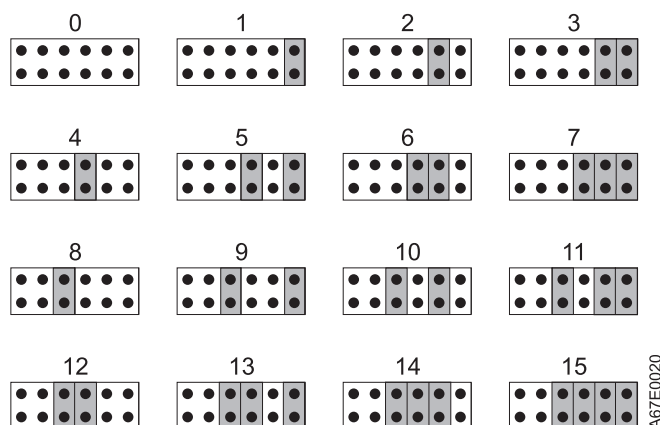


Figure 5. SCSI ID settings on the SCSI ID connector

### Setting the SCSI ID with a SCSI ID Switch

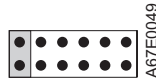
If your enclosure uses a SCSI ID switch (rather than jumpers), connect the switch to the drive's SCSI ID connector (see **2** in Figure 3 on page 3). If any jumpers are preinstalled, be sure to remove them before connecting the switch. The SCSI ID switch must be compatible with the drive's SCSI ID connector and must make an electrical connection between the same pins as the jumpers to achieve the same corresponding SCSI ID.

## Setting the SCSI ID through the LDI Interface

If the drive is being installed into a tape library, a command can be issued from the library to set the drive's SCSI ID through the LDI interface. Make sure that the SCSI ID is set to 15 (see Figure 5 on page 11). When configured to accept its SCSI ID through the LDI interface, the drive does not respond to SCSI commands until it receives a SET<sup>TM</sup> CONFIGURATION command through the interface.

## Supplying TERMPower (SCSI Drive Only)

To supply TERMPower to the bus, locate one of the five jumpers shipped with the drive and place it on the SCSI ID connector as shown in the following figure. Place the jumper on the pins that are shaded.



### Attention

SCSI termination must be provided externally to the drive.



## Mount the Drive into the Enclosure

The drive may be shipped with or without a front bezel (see **1** in Figure 6).

### To mount the drive into an enclosure:

- \_\_\_ 1. Remove the cover of your enclosure (refer to the instructions in the documentation provided with your enclosure).
- \_\_\_ 2. Place the drive into the enclosure so that the tape load compartment of the drive faces the tape load compartment of the enclosure.
- \_\_\_ 3. Insert two M3 screws into the mounting holes **2** of the two side brackets located on the left and right sides of the chassis.

#### Attention

When inserted into the drive, the length of the mounting screws must not exceed 3.5 mm (0.14 in.) inside the chassis. If the length exceeds this measurement, the drive may become damaged.

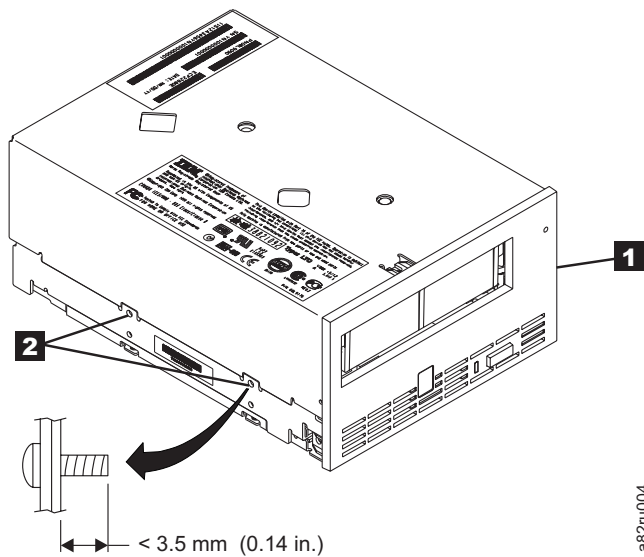


Figure 6. Mounting holes on drive. The holes are located on both sides of the drive. The drive is shown with a front bezel.

---

## Connect and Test Power to the Drive

The drive does not contain its own power source; it must be powered externally.

To connect and test power to the drive:

- \_\_\_ 1. Ensure that the enclosure (or unit that supplies power to the drive) is powered off.
- \_\_\_ 2. Ensure that the power cord is disconnected from both the enclosure and the power outlet.
- \_\_\_ 3. Connect the enclosure's internal power cable to the power connector on the drive (see **3** in Figure 3 on page 3).
- \_\_\_ 4. Connect the power cord to the enclosure and to the electrical outlet.
- \_\_\_ 5. Review the location of the Single-character Display (SCD) and the Status Light in Figure 2 on page 2 (if your drive does not have a bezel, note that the bulb of the Status Light is recessed and the light is not visible until lit). To ensure that the drive is receiving power, watch for the following while turning on the power to the enclosure:
  - The SCD presents a series of random characters, then becomes blank (not lit).

### Attention

If the SCD does not come on, the drive may not be getting power.

- The Status Light briefly becomes solid amber, then becomes solid green.
- \_\_\_ 6. Power-off the enclosure.
  - \_\_\_ 7. Disconnect the power cord from both the enclosure and the electrical outlet.

---

## Connect the Internal SCSI Cable

Connect the enclosure's internal SCSI cable to the SCSI connector on the drive (see **1** in Figure 3 on page 3).

---

## Connect the Internal LDI Cable (optional)

**Note:** Use this step only if you are installing the drive into a library control system. The drive uses the Library/Drive Interface (LDI) to communicate with a tape library.

Connect the enclosure's internal LDI cable to the LDI connector on the drive (see **4** in "Rear Panel of the SCSI Drive" on page 3).

---

## Run Drive Diagnostics

- \_\_\_ 1. Replace the cover on the enclosure.
- \_\_\_ 2. Connect the power cord to both the enclosure and the electrical outlet.
- \_\_\_ 3. Power-on the enclosure.
- \_\_\_ 4. Run one or more of the following drive diagnostics:
  - “Function Code 1: Run Drive Diagnostics” on page 23
  - “Function Code 6: Run SCSI Wrap Test” on page 27).
  - “Function Code 7: Run RS-422 Wrap Test” on page 28

If an error code appears on the single-character display (SCD), go to Table 6 on page 43. If no error appears, continue to the next step.

- \_\_\_ 5. Power-off the enclosure.
- \_\_\_ 6. Disconnect the power cord from both the enclosure and the electrical outlet.

---

## Install Device Drivers

For information about installing device drivers, refer to the documentation for your enclosure.

---

## Connect the Enclosure’s External SCSI Interface to the Server

- \_\_\_ 1. Connect an external SCSI bus cable to both the enclosure and the server (for the location of the connectors, refer to the documentation for your enclosure and server).
- \_\_\_ 2. Run the appropriate SCSI attachment verification procedure from your server (for instructions, refer to the *IBM® Ultrium Device Drivers Installation and User’s Guide*).

If you want to power a device on or off while it is connected to the same SCSI bus as the drive, you can do so if, during the power-on cycle, you quiesce all devices (including the drive) on the bus.

---

## Connect the External LDI Interface to the Server (optional)

Use this step only if your enclosure requires an LDI interface.

To perform a checkout of the drive, connect the enclosure’s external LDI cable to the server (for the location of the external LDI connector, refer to the documentation for the enclosure).

---

## Configure the Drive to the Server, Switch, or Hub

To configure the SCSI drive to the server, switch, or hub, refer to the documentation for that server, switch, or hub.

The drive is now ready for use.



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## Operating the Drive

Operating the drive involves using the following front panel items:

- Single-character Display (SCD)
- SCD Dot
- Status Light
- Unload Button

---

### Single-character Display (SCD)

The SCD ( **3** in “Front Panel of the Drive” on page 2) presents a single-character code for:


- Error conditions and informational messages
- Diagnostic or maintenance functions (while in maintenance mode only)

“Error Codes and Messages” on page 43 lists the codes for error conditions and informational messages. If multiple errors occur, the code with the highest priority (represented by the lowest number) displays first. When the error is corrected, the code with the next highest priority displays, and so on until no errors remain.

“Diagnostic and Maintenance Functions” on page 22 lists the single-character codes that represent diagnostic or maintenance functions. To initiate a function the unit must be in maintenance mode.

The SCD is blank during normal operation.

### SCD Dot

If a drive dump is present while the drive is in maintenance mode, a single red dot illuminates in the lower right corner of the SCD (  ). To copy the dump, see “Function Code 5: Copy Drive Dump” on page 26.

The SCD Dot turns off when you obtain the dump (by using an FMR tape, a SCSI command, or a library command).

## Status Light

The Status Light (**1** in Figure 2 on page 2) is a light-emitting diode (LED) that provides information about the state of the drive. The light can be green or amber, and (when lit) solid or flashing. Table 1 lists the conditions of the Status Light and Single-character Display (SCD) and provides an explanation of what each condition means.

Table 1. Meaning of Status Light and Single-character Display (SCD)






If the Status Light is...	and the SCD is...	Meaning
Off	Off	The drive has no power or is powered off.
Green	Off	The drive is powered on and in an idle state.
Flashing Green	Off	The drive is reading from the tape, writing to the tape, rewinding the tape, locating data on the tape, loading the tape, or unloading the tape.
Flashing Green	Off	The drive contains a cartridge during the power-on cycle. In this case, the drive completes POST and slowly rewinds the tape (the process may take up to ten minutes). The light stops blinking and becomes solid when the drive completes the recovery and is ready for a read or write operation. To eject the cartridge, press the unload button.
Amber	Displaying Error Code	The drive is displaying error code(s) from the error code log on the SCD. For more information, see “Function Code 9: Display Error Code Log” on page 29 and “Error Codes and Messages” on page 43.
Amber	Red numbers, letters, or segments	The drive is powering on, resetting, or in maintenance mode.
Amber	Flashing 	The drive is exiting from maintenance mode. For more information, see “Function Code 0: Exit Maintenance Mode” on page 22.
Amber	Flashing selected function	The drive is executing the selected function while in maintenance mode.
Flashing Amber once per second	Displaying error code	An error occurred and the drive or media may require service, or it may require cleaning. Note the code on the SCD, then go to Table 6 on page 43 to determine the action that is required.
Flashing Amber once per second	Displaying 	The drive needs cleaning.
Flashing Amber twice per second	Displaying Function Code  or Off	The drive is updating firmware. <sup>1</sup> The SCD will display a  if using an FMR cartridge. The SCD will be off if using the SCSI interface. For more information, see “Updating Firmware” on page 35.
Flashing Amber twice per second	Off	The drive detected an error and is performing a firmware recovery. It will reset automatically.
Flashing Amber twice per second	Flashing 	The drive is requesting a cartridge to be loaded.



Table 1. Meaning of Status Light and Single-character Display (SCD) (continued)

If the Status Light is...	and the SCD is...	Meaning
Flashing Amber twice per second	Off	There is a drive dump in flash memory.
<sup>1</sup> Power should not be removed from the drive until the microcode update is complete. The drive indicates that the update is complete by resetting and performing POST.		

## Unload Button

The Unload Button (  in Figure 2 on page 2) performs the following functions:

Table 2. Functions that the Unload Button performs

Unload Button Function	How to Initiate the Function
Rewind the tape into the cartridge and eject the cartridge from the drive	Press the Unload Button once. The Status Light flashes green while the drive is rewinding and unloading. <b>Note:</b> During a rewind and eject operation, the drive does not accept SCSI commands from the server.
Place the drive in maintenance mode	Ensure that the drive is unloaded. Then, within two seconds, press the Unload Button three times. The drive is in maintenance mode when the Status Light becomes solid amber and  appears in the SCD. <b>Note:</b> While in maintenance mode, the drive does not accept SCSI interface commands.
Scroll through the maintenance functions	While in maintenance mode, press the Unload Button once per second to increment the display characters by one. When you reach the character of the diagnostic or maintenance function that you want (see “Diagnostic and Maintenance Functions” on page 22), press and hold the Unload Button for three seconds.
Exit maintenance mode	Press the Unload Button once per second until  displays. Then press and hold the Unload Button for three seconds. Maintenance mode is exited when the Status Light becomes solid green and the SCD becomes blank.
Force a drive dump (part of the maintenance mode)	<b>Attention:</b> If the drive detects a permanent error and displays an error code, it automatically forces a drive dump (also known as a save of the firmware trace). If you force a drive dump, the existing dump will be overwritten and data will be lost. After you force a drive dump, do not turn off the power to the drive or you may lose the dump data.  Choose one of the following procedures: <ul style="list-style-type: none"> <li>• If the drive is in maintenance mode (Status Light is solid amber), refer to “Function Code 4: Force a Drive Dump” on page 25.</li> <li>• If the drive is in operating mode (Status Light is solid or flashing green), press and hold the Unload Button for ten seconds.</li> </ul> If captured dump data exists, the drive places it into a dump area (for information about retrieving the data, see “Obtaining a Drive Dump” on page 47).
Reset the drive	Press and hold the Unload Button on the drive for ten seconds. The drive saves a dump of the current drive state, then reboots to allow communication. Do not cycle power as this will erase the contents of the dump.

---

## Inserting a Tape Cartridge

To insert a tape cartridge:

1. Ensure that the drive is powered-on.
2. Ensure that the write-protect switch is properly set (see “Write-Protect Switch” on page 39).
3. Grasp the cartridge so that the write-protect switch faces you (see **1** in Figure 7).
4. Slide the cartridge into the tape load compartment.

### Notes:

- a. If the cartridge is already in an ejected position and you want to reinsert it, remove the cartridge then insert it again.
- b. If the cartridge is already loaded and you cycle the power (turn it off, then on), the tape will reload.

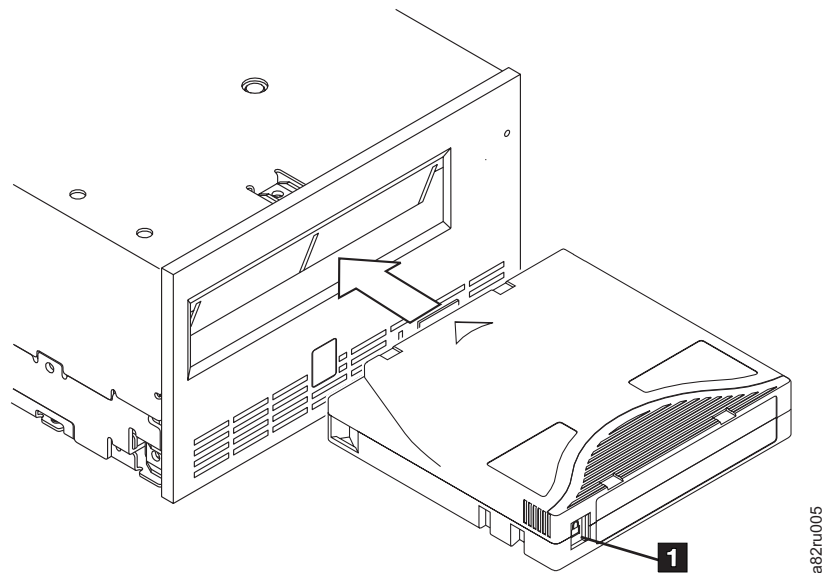


Figure 7. Inserting a cartridge into the drive



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## Removing a Tape Cartridge

To remove a tape cartridge:

1. Ensure that the drive is powered-on.
2. Press the Unload Button. The drive rewinds the tape and partially ejects the cartridge. The Status Light flashes green while the tape rewinds, then goes out before the cartridge partially ejects.
3. After the cartridge partially ejects, grasp the cartridge and remove it.

Whenever you unload a tape cartridge, the drive writes any pertinent information to the cartridge memory.

---

## Mid-tape Recovery


If a power cycle or reset occurs while a cartridge is loaded, the drive will slowly rewind the tape and eject the cartridge.

---

## Cleaning the Drive Head

### Attention

When cleaning the drive head, use the LTO Ultrium Cleaning Cartridge.

Clean the drive head whenever  displays on the Single-character Display and the Status Light is flashing amber once per second. It is not recommended that you clean the drive head on a periodic basis; only when the drive requests to be cleaned.

To clean the head, insert the cleaning cartridge into the tape load compartment (see “Front Panel of the Drive” on page 2). The drive performs the cleaning automatically in less than two minutes then ejects the cartridge.

**Note:** If a cleaning cartridge is inserted when the drive does not need to be cleaned or a cleaning cartridge is inserted that has expired, the drive will automatically eject the cartridge.

The LTO Ultrium Cleaning Cartridge is valid for 50 uses.

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## Diagnostic and Maintenance Functions

The drive can:

- Run diagnostics
- Test write and read functions
- Test a suspect tape cartridge
- Update its own firmware
- Perform other diagnostic and maintenance functions


The drive must be in maintenance mode to perform these functions.

### Attention

Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the tape drive does not accept SCSI commands from the server. The tape drive does accept LDI or RS-422 commands.

## Entering Maintenance Mode

The drive must be in maintenance mode to run drive diagnostics or maintenance functions. To place the unit in maintenance mode:


1. Make sure that no cartridge is in the drive.
2. Press the Unload Button three times within two seconds.  appears in the Single-character Display (SCD), and the Status Light turns amber.

**Note:** If a cartridge is in the tape drive, it will eject the first time that you press the Unload Button and the drive will not be placed in maintenance mode. To continue placing the drive in maintenance mode, perform the preceding step.

Maintenance functions cannot be performed concurrently with read or write operations. While in maintenance mode, the drive does not receive SCSI commands from the server.

## Function Code 0: Exit Maintenance Mode

Function Code  makes the drive available for reading and writing data.


1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode.”
2. Press and hold the Unload Button for 3 or more seconds to take the drive out of maintenance mode. The Status Light turns off.
  - If no error is detected,  temporarily appears in the SCD, then goes blank. The drive then exits maintenance mode.
  - If an error is detected, the SCD shows an error code but still exits maintenance mode. To determine the error, locate the code in Table 6 on page 43. To clear the error, turn the power off, then on again.

The drive also exits maintenance mode automatically after it completes a maintenance function or after 10 minutes if no action has occurred.

## Function Code 1: Run Drive Diagnostics

Approximate Run Time = 20 minutes per loop





Total Number of Loops = 10

Function Code  runs tests that determine whether the drive can properly load and unload cartridges, and read and write data.


The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.


### Attention

For this test, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select function . The SCD changes to a flashing .
4. Insert a scratch (blank) data cartridge that is not write-protected (or the tape drive exits maintenance mode). The SCD changes to a flashing  and the test begins.

**Note:** If you inserted an invalid or write-protected tape cartridge, error code


 appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.




- If no error is detected, the diagnostic will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends,  temporarily appears in the SCD. The drive rewinds and unloads the cartridge, and then exits maintenance mode. The solid amber Status Light turns off.
- If an error is detected, the Status Light flashes amber and the drive posts an error code to the SCD. To determine the error, locate the code in Table 6 on page 43. The tape drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

## Function Code 2: Update Drive Firmware from FMR Tape


### Attention

When updating drive firmware, do not power-off the drive until the update is complete or the firmware may be lost.

Function Code  loads drive firmware from a field microcode replacement (FMR) tape.




1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert the FMR tape cartridge (or the tape drive exits maintenance mode). The SCD changes to a flashing . The tape drive loads the updated firmware from the FMR tape into its erasable programmable read-only memory (EPROM) area.
  - If the update completes successfully, the tape drive rewinds and unloads the FMR tape, resets itself, and is ready to use the new firmware. The drive automatically reboots.
  - If the update fails, the tape drive posts an error code to the SCD. To determine the error, locate the code in Table 6 on page 43. The drive then unloads the FMR tape and exits maintenance mode. Contact Tandberg Data Technical Support for problem determination or machine replacement.


## Function Code 3: Create FMR Tape

Function Code  copies the drive's field microcode replacement (FMR) data to a scratch data cartridge.

### Attention


For this function, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.



1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert a scratch (blank) data cartridge that is not write protected (or the tape drive exits maintenance mode). The SCD changes to a flashing . The tape drive copies the FMR data to the scratch data cartridge.

**Note:** If you inserted an invalid or write-protected tape cartridge, error code  appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

- If the tape drive creates the FMR tape successfully, it rewinds and unloads the new tape, exits maintenance mode, and the tape is ready to use.
- If the tape drive fails to create the FMR tape, it displays an error code. To determine the error, see Table 6 on page 43. The tape drive then unloads the FMR tape, exits maintenance mode.

## Function Code 4: Force a Drive Dump

Function Code  performs a dump of data collected by the drive (this process is also known as saving a microcode trace).

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The drive performs the dump. The SCD shows , then goes blank. To access the contents of the dump, see "Function Code 5: Copy Drive Dump" on page 26.

**Note:** You can also force a drive dump when the tape drive is in normal operating mode. Simply press and hold the Unload Button for ten seconds.

## Function Code 5: Copy Drive Dump

Function Code **5** copies data from a drive dump (captured in Function Code 4) to the beginning of a scratch (blank) data cartridge.

### Attention

For the **5** - **1** function, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second to cycle through the following functions:

- **5** - **0** : no function
- **5** - **1** : copy dump to tape
- **5** - **2** : copy dump to flash memory
- **5** - **3** : erase flash memory

If you cycle past the desired code, press the Unload Button once per second until the code reappears.

3. Press and hold the Unload Button for three or more seconds, then release it to select one of the above functions. The SCD changes to a flashing **5**.
4. Insert a scratch (blank) data cartridge that is not write protected (or the tape drive exits maintenance mode). The SCD flashes the selection number while performing the function.


**Note:** If you inserted an invalid or write-protected tape cartridge, error code **7** appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

- If the copy operation completes successfully, the tape drive rewinds and unloads the tape, and exits maintenance mode.
- If the copy operation fails, an error code appears in the SCD. To determine the error, locate the code in Table 6 on page 43. The tape drive unloads the tape cartridge and exits maintenance mode.





## Function Code 6: Run SCSI Wrap Test

Approximate Run Time = 10 seconds per loop

Number of Loops = This test runs until stopped by pressing the Unload Button.

Function Code  performs a check of the SCSI circuitry from and to the SCSI connector.

**Note:** This test requires that the drive be terminated by either the terminator on the connector or at the end of the bus. Before you select this function, disconnect the SCSI cable of the drive that is closest to the server. Then, attach the SCSI wrap plug to that SCSI connector.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Make sure that the SCSI wrap plug is connected to one of the SCSI connectors at the rear of the drive.
4. Make sure that the drive is terminated at one of its SCSI connectors or at the SCSI bus.
5. Press and hold the Unload Button for three or more seconds, then release it to select the function. The drive automatically starts the test (one loop of which lasts for less than one second).
  - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, function code  temporarily appears in the Single-character Display. The drive then exits maintenance mode. Disconnect the SCSI wrap plug.
  - If an error is detected, the test stops, error code  appears in the SCD. To determine the error, locate  in Table 6 on page 43. To clear the error, turn the power off, then on again.

## Function Code 7: Run RS-422 Wrap Test

This test causes the drive to perform a check of the circuitry from and to the LDI or RS-422 connector.

Before selecting this function, attach an LDI or RS-422 wrap plug to the drive's LDI or RS-422 connector (in place of the LDI or RS-422 cable).

1. Make sure that no cartridge is in the drive.
2. Within a 1.5-second interval, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per 1.5 seconds until **7** appears in the Single-character Display (SCD). If you cycle past **7**, continue to press the Unload Button until it displays again.
4. To select the function, press and hold the Unload Button for three seconds.

After you select the function, **7** flashes and the drive automatically starts the test.

- If the test is successful, it loops and begins again. To half the test, press the Unload Button. The test continues to the end of its loop and then stops. The drive then displays **0** and exits maintenance mode.
- If the test fails, **9** displays, the test stops, and the drive exits maintenance mode. To resolve the error, locate **9** in Table 6 on page 43



## Function Code 8: Unmake FMR Tape


Function Code **8** erases the field microcode replacement (FMR) data and rewrites the cartridge memory on the tape. This converts the cartridge into a valid scratch (blank) data cartridge.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 22.
2. Press the Unload Button once per second until **8** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select function **8**. The SCD changes to a flashing **8**.
4. Insert the FMR data cartridge (or the tape drive exits maintenance mode). The SCD changes to a flashing **8**. The tape drive erases the firmware on the tape and rewrites the header in the cartridge memory to change the cartridge to a valid scratch (blank) data cartridge:
  - If the operation is successful, the tape drive displays function code **0**, rewinds and unloads the newly converted scratch data cartridge, and exits maintenance mode.
  - If the operation is not successful, an error code displays. To determine the error, locate the code in Table 6 on page 43. To clear the error, turn the power off, then on again.







## Function Code 9: Display Error Code Log

Function Code  displays the last ten error codes, one at a time (the codes are ordered; the most recent is presented first and the oldest is presented last). If there are no errors in the log, function code  displays in the Single-character Display (SCD).

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to view the most recent error codes.
4. Press the Unload Button again to view successive error codes. Let two to three seconds pass between each depression.
5. After viewing all error codes, exit this function and maintenance mode by pressing the Unload Button again.

## Function Code A: Clear Error Code Log

Function Code  erases the contents of the error code log.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function.  flashes in the SCD, followed by . The tape drive erases all errors from the error code log. The tape drive exits maintenance mode.

## Function Code C: Insert Cartridge into Tape Drive

This function cannot be selected by itself, but is part of other maintenance functions (such as Run Tape Drive Diagnostics and Create FMR Tape) that require a tape cartridge to be inserted.

## Function Code E: Test Cartridge & Media

Approximate Run Time = 15 minutes per loop

Total Number of Loops = 10

Function Code **E** performs tests that determine whether a suspect cartridge and its magnetic tape are acceptable.

The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.

### Attention

When you perform this test, data on the suspect tape will be overwritten.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until **E** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **E**.
4. Ensure that the write-protect switch on the suspect cartridge is off, then insert the cartridge (or the tape drive exits maintenance mode). The SCD changes to **E**. The tape drive runs the tests.
  - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds the tape, unloads the cartridge, and exits maintenance mode.
  - If an error is detected the test stops, **6** or **7** appears in the SCD (another code could appear). To determine the error, locate **6** or **7** in Table 6 on page 43. The drive unloads the tape cartridge, exits maintenance mode. To clear the error, turn the power off, then on again.

## Function Code F: Fast Read/Write Test

Approximate Run Time = 5 minutes

Total Number of Loops = 10

Function Code **F** performs tests to ensure that the drive can read from and write to tape.

The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.

### Attention

For this test, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press the Unload Button once per second until **F** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **F**.
4. Insert a scratch (blank) data cartridge that is not write-protected (or the tape drive exits maintenance mode). The SCD changes to a flashing **F**. The tape drive runs the tests.

**Note:** If you inserted an invalid or write-protected tape cartridge, **7** appears in the SCD. The tape drive unloads the cartridge and exits maintenance mode.

- If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, **0** temporarily appears in the SCD. The drive rewinds and unloads the tape, partially ejects the cartridge, then exits maintenance mode. The solid amber Status Light turns off.
- If an error is detected, the Status Light flashes amber, the tape drive posts an error code to the SCD. To determine the error, locate the code in Table 6 on page 43. The tape drive unloads the cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

## Function Code H: Test Head

Approximate Run Time = 10 minutes

Total Number of Loops = 10

Function Code **H** performs tests to ensure that the tape drive's head and tape-carriage mechanics work correctly.

The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.

### Attention

For this test, insert only a scratch (blank) data cartridge or a cartridge that may be overwritten. During the test, the drive overwrites the data on the cartridge.

1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 22.
2. Press the Unload Button once per second until **H** appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing **C**.
4. Insert a scratch (blank) data cartridge that is not write-protected (or the tape drive exits maintenance mode). The SCD changes to a flashing **H**. The tape drive runs the tests.
  - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends, **C** temporarily appears in the SCD. The drive rewinds the tape and unloads the cartridge. The drive then exits maintenance mode.
  - If an error is detected the test stops, error code **S** appears in the SCD. To determine the error, locate **S** in Table 6 on page 43. The drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.

## Function Code L: Load/Unload Test

Approximate Run Time = 3 seconds per loop







Total Number of Loops = 10

Function Code  tests the drive's ability to load and unload a tape cartridge.


The diagnostic loops ten times. To stop the diagnostic and exit maintenance mode, press the Unload Button once to abort the test.



### Attention

Even though no data is written during this test, it is recommended that you use a blank (scratch) cartridge for this test.


1. Place the drive in maintenance mode. For instructions, see "Entering Maintenance Mode" on page 22.
2. Press the Unload Button once per second until  appears in the SCD. (If you cycle past the desired code, press the Unload Button once per second until the code reappears.)
3. Press and hold the Unload Button for three or more seconds, then release it to select the function. The SCD changes to a flashing .
4. Insert a scratch (blank) data cartridge that is not write-protected (or the tape drive exits maintenance mode). The SCD changes to a flashing . The tape drive runs the tests.
  - If no error is detected, the test will loop and begin again. To stop the loop, press the Unload Button for one second and release. When the loop ends,  temporarily appears in the SCD. The drive rewinds the tape and unloads the cartridge. The drive then exits maintenance mode.
  - If an error is detected the test stops,  appears in the SCD. To determine the error, locate  in Table 6 on page 43. The drive unloads the tape cartridge and exits maintenance mode. To clear the error, turn the power off, then on again.



## Function Code P: Enable Post Error Reporting

When selected, deferred-check conditions are reported to the host. Therefore, temporary errors are reported in the sense data. This selection is normally used as a request from support personnel. Default is  (disabled).

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  then exits maintenance mode.

## Function Code U: Disable Post Error Reporting

When selected, turns Post Error reporting off. Deferred-check conditions (temporary errors) are NOT reported to Host (normal mode of drive operation). Default is  (disabled).

1. Place the drive in maintenance mode. For instructions, see “Entering Maintenance Mode” on page 22.
2. Press and hold the Unload Button for three seconds while  appears in the SCD. The SCD changes to  then exits maintenance mode.

---

## Updating Firmware

### Attention:

When updating firmware, do not power-off the drive until the update is complete, or the firmware may be lost.

Periodically check for updated levels of drive firmware by visiting the web at **www.tandberg.com**. Update drive firmware using:

- The SCSI interface
- The LDI or RS-422 interface
- A field microcode replacement (FMR) tape cartridge

For instructions on obtaining a new firmware image or FMR tape, visit **www.tandberg.com**. To update the firmware, refer to the following sections.

### Updating Firmware through the SCSI Interface

When updating drive firmware by using the SCSI interface, the procedure varies, depending on whether your server uses an IBM tape device driver or a non-IBM tape device driver (such as a driver from Sun, Hewlett-Packard, or Microsoft®).

For instructions about updating firmware from a server that uses an IBM tape device driver, refer to the *IBM Ultrium Device Drivers Installation and User's Guide*.

To update firmware from a server that uses a non-IBM tape device driver, refer to the documentation for that device.

### Updating Firmware through the Library/Drive Interface

The drive includes a firmware update feature that allows a tape library to download firmware to the drive by using the Library/Drive Interface (LDI) while the drive performs normal host operations on logical unit number (LUN) 0 of the SCSI Protocol Interface. The update typically takes 63 seconds and a maximum of 140 seconds. The command may be received by the SCSI interface or the LDI (RS-422) interface.

**Note:** If a Power-on Reset command is received while a cartridge is loaded in the drive, the drive will respond with a Check Condition. It will not activate the new code level until you cycle power, or until a Power-on Reset command is received and the drive does not contain a cartridge.





### Updating the Firmware with an FMR Tape Cartridge

#### Tip

After creating an FMR tape (see “Function Code 3: Create FMR Tape” on page 25), the firmware of multiple drives can be updated with the same FMR tape. After updating the drive firmware, unmake the FMR tape (see “Function Code 8: Unmake FMR Tape” on page 28) and use it as a data cartridge.

To update the drive's firmware from an FMR tape cartridge:

1. Ensure that a cartridge is not loaded in the drive.

2. Place the drive in maintenance mode by pressing the Unload Button three times within a two seconds. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  displays, then press and hold the button for three seconds. When  flashes, the drive is waiting for a cartridge.
4. Insert the FMR tape cartridge.  flashes, the drive loads the updated firmware from the cartridge, and the Status Light flashes amber. When the update completes successfully,  displays and the cartridge automatically ejects.

The drive resets itself and automatically activates the new firmware.

If the update fails, an error code displays. To resolve the error, locate the code in Table 6 on page 43.



---

## Using Ultrium Media

Figure 8 shows the LTO Ultrium 400 GB Data Cartridge and its components.

- |          |                      |          |                      |
|----------|----------------------|----------|----------------------|
| <b>1</b> | LTO cartridge memory | <b>4</b> | Write-protect Switch |
| <b>2</b> | Cartridge door       | <b>5</b> | Label area           |
| <b>3</b> | Leader Pin           | <b>6</b> | Insertion guide      |

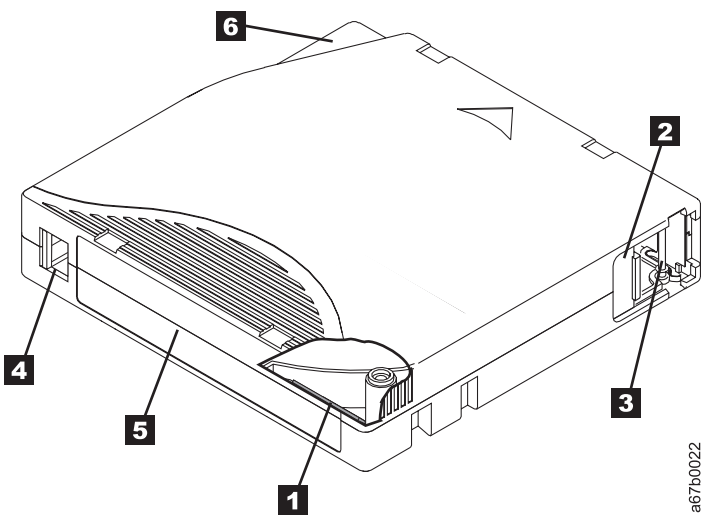


Figure 8. The LTO Ultrium 400 GB Data Cartridge

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## Cartridge Compatibility

Table 3. Ultrium data and cleaning cartridge compatibility with Ultrium tape drive

Tape Drive	LTO Ultrium Data Cartridges		
	400 GB (Ultrium 3)	200GB (Ultrium 2)	100GB (Ultrium 1)
Ultrium 3	Read/Write	Read/Write	Read only
Ultrium 2		Read/Write	Read/Write
Ultrium 1			Read/Write

---

## Data Cartridge

All three generations contain 1/2-inch, dual-coat, metal-particle tape. The native data capacity of Ultrium data cartridges is as follows:

- The Ultrium 3 cartridge has a native data capacity of 400 GB (800 GB at 2:1 compression).
- The Ultrium 2 cartridge has a native data capacity of 200 GB (400 GB at 2:1 compression).
- The Ultrium 1 cartridge has a native data capacity of 100 GB (200 GB at 2:1 compression).

When processing tape in the cartridges, Ultrium Tape Drives use a linear, serpentine recording format. The Ultrium 3 drive reads and writes data on 704 tracks, sixteen tracks at a time. The Ultrium 2 drive reads and writes data on 512 tracks, eight tracks at a time. The Ultrium 1 drive reads and writes data on 384 tracks, eight tracks at a time. The first set of tracks (sixteen for Ultrium 3; eight for Ultrium 2 and 1) is written from near the beginning of the tape to near the end of the tape. The head then repositions to the next set of tracks for the return pass. This process continues until all tracks are written and the cartridge is full, or until all data is written.

The cartridge door **2** protects the tape from contamination when the cartridge is out of the drive. Behind the door, the tape is attached to a leader pin **3**. When the cartridge is inserted into the drive, a threading mechanism pulls the pin (and tape) out of the cartridge, across the drive head, and onto a non-removable take-up reel. The head can then read or write data from or to the tape.


The write-protect switch **4** prevents data from being written to the tape cartridge (see “Write-Protect Switch” on page 39). The label area **5** provides a location to place a label. The insertion guide **6** is a large, notched area that prevents the cartridge from being inserted incorrectly.

Both generations of the LTO Ultrium Data Cartridge have a nominal cartridge life of 5000 load and unload cycles.

---

## Cleaning Cartridge

With each drive, a specially labeled LTO Ultrium Cleaning Cartridge is supplied to clean the drive heads. The drive itself determines when a head needs to be

cleaned. It alerts you by displaying  on the Single-character Display. To clean the head, insert the cleaning cartridge into the tape load compartment (see Figure 7 on page 20). The drive performs the cleaning automatically. When the cleaning is finished, the drive ejects the cartridge.

**Note:** If a cleaning cartridge is inserted when the drive does not need to be cleaned or when the cartridge has expired, the drive will automatically eject the cartridge.


To remove a cleaning cartridge, see “Unload Button” on page 19.

The Cleaning Cartridges are valid for 50 uses.

---

## Write-Protect Switch

The position of the write-protect switch on the tape cartridge (see **1** in Figure 9) determines whether you can write to the tape. If the switch is set to the:

- The locked position  (solid red), data cannot be written to the tape.
- The unlocked position (black void), data can be written to the tape.

If possible, use your server's application software to write-protect your cartridges (rather than manually setting the write-protect switch). This allows the server's software to identify a cartridge that no longer contains current data and is eligible to become a scratch (blank) data cartridge. Do not write-protect scratch (blank) cartridges; the tape drive will not be able to write new data to them.

If you must manually set the write-protect switch, slide it left or right to the desired position.

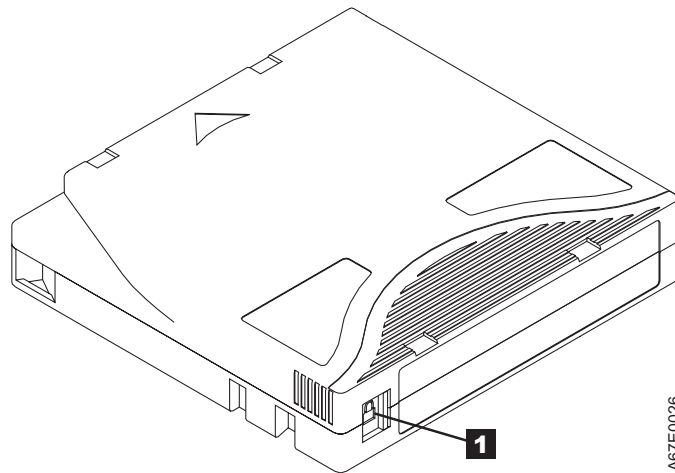


Figure 9. Setting the write-protect switch



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## Resolving Problems

If you encounter problems when running the drive, refer to Table 4. If the problem is not identified in Table 4, refer to “Methods of Receiving Errors and Messages” on page 42. The color and condition of the Status Light may also indicate a problem. For more information, see “Status Light” on page 18.

*Table 4. Troubleshooting tips*

If the problem is this....	Do this....
A code displays on the Single-character Display (SCD) and the Status Light flashes amber.	The drive detected an error or is directing you to an informational message. See Table 6 on page 43.
The Status Light or SCD never turns on.	The drive has no power. Check the power at the power source. Connect power to the drive (see “Connect and Test Power to the Drive” on page 14). If the problem persists, replace the drive.
The drive will not load a tape cartridge.	One of the following has occurred: <ul style="list-style-type: none"><li>• A tape cartridge is already inserted. To remove the cartridge, press the Unload Button. If the cartridge does not eject, turn off the power to the drive, then turn it back on. After the Status Light becomes solid green, press the Unload Button to eject the cartridge.</li><li>• The tape cartridge was inserted incorrectly. To properly insert a cartridge, see “Inserting a Tape Cartridge” on page 20.</li><li>• The tape cartridge may be defective. Insert another tape cartridge. If the problem exists for multiple cartridges, the drive is defective. Replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51).</li><li>• The drive has no power. Connect power to the drive (see “Connect and Test Power to the Drive” on page 14).</li></ul>
The drive will not unload the tape cartridge.	The tape cartridge is stuck or is broken. Press the Unload Button. If the cartridge does not eject, turn off the power to the drive, then turn it back on (note that the mid-tape recovery could take up to ten minutes to complete). If the cartridge still does not eject, contact your service representative.
The server received TapeAlert flags.	
The server reported SCSI problems (such as selection or command time-outs, or parity errors).	See “Fixing SCSI Bus Errors” on page 49.
The library reported an LDI or RS-422 communication problem with the drive.	The LDI or RS-422 circuitry may be defective. Run the LDI or RS-422 wrap test (“Function Code 7: Run RS-422 Wrap Test” on page 28). If the test runs successfully but the problem persists, refer to your library’s service documentation.
Codes display on the SCD, but the Status Light does not turn on.	The drive is defective. Replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51).
The drive does not respond to server commands.	Press and hold the Unload Button on the drive for ten seconds to force a drive dump. The drive will save the dump and then reboot to allow communication to the drive to occur. Do not cycle power, as this will erase the contents of the dump.

---

## Methods of Receiving Errors and Messages

Use Table 5 as a guide for identifying error codes and message codes reported by the drive, its enclosure (if applicable), or the server.


**Note:** The codes on the Single-character Display (SCD) have different meanings, depending on whether they display during normal operations or while the drive is in maintenance mode. Codes that occur during normal operations are defined in Table 6 on page 43. Codes that occur while in maintenance mode are defined in “Diagnostic and Maintenance Functions” on page 22.

*Table 5. Methods of receiving errors and messages*

If the error or message was presented by....	Do this....
The enclosure's display (if the drive is enclosed in a library or autoloader)	Refer to the documentation for the enclosure.
The drive's SCD and the Status Light flashes amber	See Table 6 on page 43. To determine the meaning of Status Light activity, see “Status Light” on page 18.
The drive's SCD and the Status Light is solid amber	See “Diagnostic and Maintenance Functions” on page 22. To determine the meaning of Status Light activity, see “Status Light” on page 18.
SCSI log sense data (such as TapeAlert flags) and SCSI drive sense data at the server console	See Table 6 on page 43.
Drive sense data sent to a library (if the drive is enclosed in a library)	Refer to your library's documentation, then see Table 6 on page 43.
The drive's error log	See Table 6 on page 43 and “Viewing the Drive Error Log” on page 48.

## Error Codes and Messages

Table 6 gives descriptions of the errors and messages that pertain to the drive, and tells what to do when you receive them.

**Attention:** If the drive detects a permanent error and displays an error code other than , it automatically performs a drive dump. If you force a drive dump, the existing dump will be overwritten and data will be lost. After you force a drive dump, do not turn off the power to the drive or you may lose the dump data.

*Table 6. Error codes on the Single-character Display.* To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.





Error Code	Cause and Action
	<p>No error occurred and no action is required. This code displays:</p> <ul style="list-style-type: none"> <li>• When power is cycled (turned off, then on) to the tape drive.</li> <li>• When diagnostics have finished running and no error occurred.</li> </ul> <p><b>Note:</b> The Single-character Display is blank during normal operation of the tape drive.</p>
	<p>Cooling problem. The tape drive detected that the recommended operating temperature was exceeded. Perform one or more of the following actions:</p> <ul style="list-style-type: none"> <li>• Ensure that the cooling fan is rotating and is quiet. If not, refer to your enclosure documentation.</li> <li>• Remove any blockage that prevents air from flowing freely through the tape drive.</li> <li>• Ensure that the operating temperature and airflow is within the specified range (see “Physical Specifications” on page 6).</li> <li>• If the operating temperature is within the specified range and the problem persists, replace the drive.</li> </ul> <p>The error code clears when you power-off the tape drive or place it in maintenance mode.</p>
	<p>Power problem. The tape drive detected that the externally supplied power is approaching the specified voltage limits (the tape drive is still operating) or is outside the specified voltage limits (the tape drive is not operating). Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Ensure that the power connector is properly seated.</li> <li>2. Ensure that the proper dc voltages are being applied within the tolerances allowed (see “Physical Specifications” on page 6).</li> <li>3. If the proper voltages are being applied but the problem persists, replace the unit.</li> </ol> <p>The error code clears when you power-off the tape drive or place it in maintenance mode.</p>
	<p>Firmware problem. The tape drive determined that a firmware error occurred. Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following: <ul style="list-style-type: none"> <li><b>Note:</b> Do not force a new dump; the tape drive has already created one. <ul style="list-style-type: none"> <li>• Server’s SCSI interface by using a device driver utility or system tool</li> <li>• Ultrium Tape Drive (to copy and read a drive dump, use “Function Code 5: Copy Drive Dump” on page 26)</li> </ul> </li> </ul> </li> <li>2. Power the tape drive off and on, then retry the operation that produced the error.</li> <li>3. If the problem persists, download new firmware and retry the operation.</li> <li>4. If the problem persists, send the drive dump that you collected in step 1 to your Tandberg Data Support Center.</li> </ol> <p>The error code clears when you power-off the tape drive or place it in maintenance mode.</p>

Table 6. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
4	<p>Firmware or tape drive problem. The tape drive determined that a firmware or tape drive hardware failure occurred. Perform the following action:</p> <ol style="list-style-type: none"> <li>1. Collect a drive dump from one of the following: <ul style="list-style-type: none"> <li>• <b>Note:</b> Do not force a new dump; one already exists.</li> <li>• Server's SCSI interface by using a device driver utility or system tool</li> <li>• Ultrium Tape Drive (to copy and read a drive dump, use "Function Code 5: Copy Drive Dump" on page 26)</li> </ul> </li> <li>2. Power the tape drive off and on, then retry the operation that produced the error. The error code clears when you power-off the tape drive or place it in maintenance mode.</li> <li>3. If the problem persists, download new firmware and retry the operation; if new firmware is not available, replace the drive.</li> </ol>
5	<p>Tape drive hardware problem. The drive determined that a tape path or read/write error occurred. To prevent damage to the drive or tape, the tape drive will not allow you to insert a cartridge if the current cartridge was successfully ejected. The error code may clear when you cycle power to the tape drive or place it in maintenance mode. If the problem persists, replace the drive.</p> <p><b>Note:</b> Copy the drive dump to flash memory before returning the drive. For instructions, refer to "Function Code 5: Copy Drive Dump" on page 26.</p>



Table 6. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.














Error Code	Cause and Action
	<p>Tape drive or media error. The tape drive determined that an error occurred, but it cannot isolate the error to faulty hardware or to the tape cartridge. Perform the following action:</p> <p><b>For Problems with Writing Data:</b></p> <p>If the problem occurred while the tape drive was writing data to the tape, and if you know the volume serial number (located on the cartridge label) of the tape cartridge that was loaded in the drive when the problem occurred, retry the operation with a different cartridge:</p> <ul style="list-style-type: none"> <li>• If the operation succeeds, the original cartridge was defective. Copy data from the defective cartridge and discard it.</li> <li>• If the operation fails and another tape drive is available, insert the cartridge into the other unit and retry the operation. <ul style="list-style-type: none"> <li>– If the operation fails, discard the defective cartridge.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 23. <ul style="list-style-type: none"> <li>- If the diagnostics fail, replace the tape drive.</li> <li>- If the diagnostics succeed, the error was temporary.</li> </ul> </li> </ul> </li> <li>• If the operation fails and another tape drive is not available, insert a scratch data cartridge into the unit and run “Function Code 1: Run Drive Diagnostics” on page 23. <ul style="list-style-type: none"> <li>– If the diagnostics fail, replace the tape drive.</li> <li>– If the diagnostics succeed, discard the cartridge.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge’s volume serial number, run “Function Code 1: Run Drive Diagnostics” on page 23:</p> <ul style="list-style-type: none"> <li>• If the diagnostics fail, replace the tape drive.</li> <li>• If the diagnostics succeed, run “Function Code H: Test Head” on page 32. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p> <p><b>For Problems with Reading Data:</b></p> <p>If the problem occurred while the tape drive was reading data from the tape, and if you know the volume serial number of the tape cartridge, perform one of the following procedures:</p> <ul style="list-style-type: none"> <li>• If another tape drive is available, insert the cartridge into the other unit and retry the operation: <ul style="list-style-type: none"> <li>– If the operation fails, discard the defective cartridge.</li> <li>– If the operation succeeds, insert a scratch data cartridge into the first unit and run “Function Code 1: Run Drive Diagnostics” on page 23: <ul style="list-style-type: none"> <li>- If the diagnostic fails, replace the tape drive.</li> <li>- If the diagnostic succeeds, the error was temporary.</li> </ul> </li> </ul> </li> <li>• If another tape drive is not available, insert a scratch data cartridge into the unit and run “Function Code 1: Run Drive Diagnostics” on page 23: <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, discard the cartridge.</li> </ul> </li> </ul> <p>If the problem occurs with multiple tape cartridges or if you do not know the tape cartridge’s volume serial number, run “Function Code 1: Run Drive Diagnostics” on page 23:</p> <ul style="list-style-type: none"> <li>• If the diagnostic fails, replace the tape drive.</li> <li>• If the diagnostic succeeds, run “Function Code H: Test Head” on page 32. <ul style="list-style-type: none"> <li>– If the diagnostic fails, replace the tape drive.</li> <li>– If the diagnostic succeeds, replace the cartridges that caused the problem.</li> </ul> </li> </ul> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>

Table 6. Error codes on the Single-character Display (continued). To clear error and cycle power, press the Unload Button for ten seconds. A drive dump will be created.

Error Code	Cause and Action
	<p>A high probability of media error. The tape drive determined that an error occurred because of a faulty tape cartridge. Try another tape cartridge. If the problem occurs with multiple tape cartridges, use the following procedure:</p> <p><b>Attention:</b> When you run the Test Cartridge &amp; Media diagnostic, data on the suspect tape is overwritten. Use only a scratch data cartridge to run the test.</p> <ol style="list-style-type: none"> <li>If possible, run the tape cartridge in a different tape drive. If the operation in the other unit fails and  or  displays, replace the media. If the operation succeeds, run "Function Code E: Test Cartridge &amp; Media" on page 30. <ul style="list-style-type: none"> <li>If the diagnostic fails, replace the media.</li> <li>If the diagnostic succeeds, clean the drive head (see "Cleaning the Drive Head" on page 21) and run "Function Code 1: Run Drive Diagnostics" on page 23. <ul style="list-style-type: none"> <li>If the drive diagnostic fails, replace the drive.</li> <li>If the drive diagnostic succeeds, perform the operation that produced the initial media error.</li> </ul> </li> </ul> </li> </ol> <p>The error code clears when you remove the tape cartridge or place the tape drive in maintenance mode.</p>
	Tape drive or SCSI bus failure. The tape drive determined that a failure occurred in the tape drive's hardware or in the SCSI bus. The error code clears 10 seconds after the drive detected the error or when you place the drive in maintenance mode.
	Tape drive or RS-422 error. The tape drive determined that a failure occurred in the tape drive's hardware or in the RS-422 connection. Replace the tape drive. The error code clears 10 seconds after the drive detected the error or when you place the tape drive in maintenance mode.
	<p>Tape drive hardware problem. The tape drive determined that a problem occurred which degraded the operation of the tape drive, but it did not restrict continued use. If the problem persists, replace the drive. The drive is usable, though the Single-character Display continues to indicate an error and the Status Light flashes amber.</p> <p>The error code may clear when you cycle power to the tape drive or place it in maintenance mode.</p>
	No error or message is assigned. See error code  in this table.
	<p>The tape drive needs to be cleaned. Clean the tape drive. See "Cleaning the Drive Head" on page 21.</p> <p>The error code clears when you clean the tape drive or place it in maintenance mode.</p>
	No error or message assigned. See error code  in this table.
	The Unload Button is depressed. Verify that the button pushes freely.


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
## Obtaining a Drive Dump

You can obtain a drive dump by selecting a function code on the drive or by using a device driver utility (or a system tool) on the server. The sections that follow describe each method.

### Using the Drive

To obtain a drive dump directly from the drive:

1. Make sure that no cartridge is in the drive.
2. Within two seconds, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  appears in the Single-character Display.
4. To select the function, press and hold the Unload Button for three seconds.

After you release the button,  flashes. Within 60 seconds, insert a scratch data cartridge that is not write-protected. After you insert the cartridge,  flashes and the drive writes the dump data to the scratch tape. When the function is complete, the drive rewinds and unloads the tape.

5. Insert the tape into a drive.
6. From the server, issue the SCSI READ command to read the dump from the tape to a file or electronic image (you may need to issue the command several times to read the complete dump).
7. To determine where to send the file for analysis, contact your OEM Product Application Engineer (PAE).

### Using a Device Driver Utility

To obtain a drive dump by using a device driver utility, determine whether your server is installed with a utility that can read files from the server's memory. If it is, use that utility to obtain the drive dump.

For information about using IBM's utility programs to obtain drive dumps, see the *IBM Ultrium Device Drivers Installation and User's Guide*.


To determine where to send a file that contains a drive dump to be analyzed, contact your OEM Product Application Engineer (PAE).

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## Viewing the Drive Error Log

The drive keeps an error log that you can use to identify and correct errors. The log contains the 10 most recent error codes, which appear (one at a time) on the Single-character Display (SCD).

To view the drive error log:

1. Make sure that no cartridge is in the drive.
2. Within two seconds, press the Unload Button three times. The Status Light becomes solid amber, which means that the drive is in maintenance mode.
3. Press the Unload Button once per second until  appears in the SCD.
4. Press and hold the Unload Button for three seconds to view the most recent error code.
5. Refer to Table 6 on page 43 to determine the meaning of the code and the action to take.
6. Press the Unload Button to view the next error code. (The codes are ordered; the most recent is presented first and the oldest (tenth) is presented last.)
7. Continue to press the Unload Button until the ten error codes have been displayed. After you display the tenth error code, the drive automatically exits maintenance mode.

To redisplay the error codes, repeat steps 1 through 7.

---

## Resolving Problems Reported by the Server

The procedure for fixing SCSI bus errors varies, depending on whether the error is consistent or intermittent, and whether your configuration contains single or multiple drives. The sections that follow describe how to fix each type of error.

### Fixing SCSI Bus Errors

**Note:** If you are using a Storage Area Network (SAN) Data Gateway to convert a drive with a SCSI interface to a Fibre Channel interface, ensure that the problem is occurring between the SAN Data Gateway and the drive by running the SCSI wrap test on the drive and running the SCSI loopback test on the SAN Data Gateway. (To run the SCSI wrap test, see “Function Code 6: Run SCSI Wrap Test” on page 27; to run the SCSI loopback test, refer to the section about that test in the *IBM Storage Area Network Gateway Module Setup, Operator, and Service Guide*.)

#### Fixing a Consistent Error with a Single Drive on a SCSI Bus

1. Ensure that the power is on to the drive.
2. Ensure that the drive’s SCSI address is the same as the SCSI address assigned by the server.
3. Run the SCSI wrap test (see “Function Code 6: Run SCSI Wrap Test” on page 27).
  - If the test fails, replace the SCSI terminator first, then the SCSI cable and the interposer (if installed). Repeat the operation that caused the error. If you replaced the SCSI terminator or SCSI cable and the problem persists, the fault is with the server’s hardware or software. To isolate the cause of the failure, refer to the server’s service documentation.
  - If the test fails again, replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51).
  - If the test is successful, refer to your enclosure documentation for additional troubleshooting information.

#### Fixing a Consistent Error with Multiple Drives on a SCSI Bus

When a consistent error occurs in a configuration that has multiple drives on the SCSI bus, you must determine if the problem exists with more than one drive. If the problem is with all of the devices on the SCSI bus, the bus is stuck in a SCSI phase and cannot change to another phase or the SCSI cable from the server to the first device is defective.

1. Ensure that the SCSI cable from the server to the first device is connected.
2. Disconnect all but the first drive on the SCSI bus. Move the terminator to the first SCSI device.
3. Run a device driver utility (such as IBM’s *ntutil* or *tapeutil*) to determine whether the error will occur.
  - If the error occurs, run the SCSI wrap test on the first drive (see “Function Code 6: Run SCSI Wrap Test” on page 27).
    - If the test runs successfully, replace the SCSI terminator first, then the SCSI cable and the interposer (if installed) to the first drive. Repeat the operation that caused the error. If you replaced the SCSI terminator or SCSI cable and the problem persists, the fault is with the server’s hardware or software. To isolate the cause of the failure, refer to the server’s service documentation.

- If the test fails, replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51).
- If the error does not occur, connect one drive at a time back to the bus and repeat step 3 for each drive until you can identify which drive is defective.

**Note:** Ensure that the SCSI terminator is always on the last drive on the SCSI bus.

4. Determine if the problem is with only one drive or with two or more drives.
  - If the problem is with only one drive, run the SCSI wrap test on that drive (see “Function Code 6: Run SCSI Wrap Test” on page 27).
    - If the test runs successfully, replace the SCSI terminator first, then the SCSI cable to that drive and interposer (if installed).
    - If the test fails, replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51).
  - If the problem is with two or more drives, locate the first drive that has the error and replace the SCSI cable that connects the drive and the interposer (if installed).

### **Fixing an Intermittent Error with a Single Drive on a SCSI Bus**

1. Replace the SCSI terminator on the drive.
2. Run the operation that caused the error. If the problem persists, the problem may be with the cable.
3. Isolate which cable is causing the problem by replacing one cable at a time and running the operation that caused the error after each replacement. If the problem persists after all cables have been replaced, the problem may be with the drive.
4. Replace the drive (see “Removing a SCSI Drive from an Enclosure” on page 51). If the problem persists, the problem is with your server. Consult your server’s documentation.

### **Fixing an Intermittent Error with Multiples Drives on a SCSI Bus**

Refer to the server’s error logs to determine which drive is the source of the problem:

- If only one drive is reporting a SCSI failure, replace that drive (see “Removing a SCSI Drive from an Enclosure” on page 51).
- If multiple drives are reporting SCSI failures, the problem may be with the terminator or the SCSI cables:
  - Replace the terminator and run the operation that caused the error. If the problem persists, the problem may be with the cables.
  - Isolate which cable is causing the problem by replacing one cable at a time and run the operation that caused the error after each replacement.

---

## Servicing the Drive

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### Removing a SCSI Drive from an Enclosure

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To remove a SCSI drive from an enclosure, perform the following steps:

1. Ensure that the drive does not contain a tape cartridge.
2. Deconfigure the drive from the server (for instructions, see your server's documentation).
3. Turn off the power to the enclosure. Disconnect the power cable from the enclosure and the electrical outlet.
4. Remove the cover of the enclosure.
5. Disconnect the internal power cable from the power connector (see **3** in Figure 3 on page 3).
6. If connected, disconnect the internal LDI (RS-422) cable from the LDI (RS-422) connector (see **4** in Figure 3 on page 3).
7. Disconnect the internal SCSI cable from the SCSI connector (see **1** in Figure 3 on page 3).
8. Perform one of the following procedures on the SCSI ID connector (see **2** in Figure 3 on page 3):
  - If your enclosure uses an internal SCSI ID switch, disconnect it from the SCSI ID connector.
  - If your enclosure uses jumpers to set the SCSI ID, do not remove them from the connector.
9. Remove the mounting screws from the side brackets of the chassis (see **2** in Figure 6 on page 13).
10. Remove the drive from the enclosure.
11. To reassemble, reverse these steps.

---

## Manually Removing a Tape Cartridge

The purpose of this section is to assist you in determining the condition of the cartridge or the magnetic tape and to direct you to the procedure you must follow to remove the cartridge.

### Attention

- Before using this procedure, you must have exhausted all other means of removing the tape cartridge from the drive. Use this procedure **only** if you cannot remove the tape cartridge by using any other means.
- Determine from the customer if the cartridge contains **critical customer data**. If the cartridge contains sensitive data that cannot leave the site, inform the customer that certain failure conditions diagnostics will be performed to test the drive for continued use.
- The following removal procedures **can destroy** customer data! Use **extreme care** when handling or removing the customer's tape cartridges to minimize tape damage and lost data.
- **DO NOT TOUCH** the magnetic tape or tape path. Both are extremely sensitive to the oil and salt from your skin. Use clean, lint-free gloves when working around magnetic tape or the tape path components.
- Electrostatic-sensitive components: Consider using an ESD Kit.
- After you remove the tape cartridge, advise the customer to copy the data to another cartridge and to remove this tape cartridge from service.
- Do not use power tools or magnetic tools to perform this procedure.
- To avoid contamination and electrostatic-discharge damage to the drive, never touch the head or electronic components inside the drive.
- If you cannot remove the cartridge from the drive using the following procedures, contact your next level of support.

## Before You Begin

1. If you have not already done so, attempt to remove the cartridge with the device power ON and using library manager, a host application, or the Unload Button.
2. If you have not already done so, attempt to remove the cartridge by power cycling the drive. Look for the drive to attempt a mid-tape recovery.

**Note:** It can take as long as five minutes for the cartridge to rewind and unload.

3. If the cartridge unloads, inform the operator that the cartridge is unloaded. If the cartridge does not unload, continue with this procedure.

## Recommended Tools

- 2.5 mm offset hex wrench (do not use magnetized wrench)
- #1 Phillips screwdriver
- ESD Kit
- Flashlight (optional)
- #1 Flathead screwdriver (optional)



## Beginning Procedure

- \_\_\_ Step 1. Refer to the enclosure documentation for instructions on removing the drive.
- \_\_\_ Step 2. Place the drive on a non-slip, sturdy work surface.
- \_\_\_ Step 3. Ground yourself to the drive by using an ESD Kit.
- \_\_\_ Step 4. Remove the cover of the drive by performing the following steps:
  - a. Using a Phillips screwdriver, remove the three screws and washers (see **1** in Figure 10) that secure the bezel **2** to the internal drive, then remove the bezel.
  - b. Remove the cover of the internal drive by performing the following steps:
    - 1) Remove the four cover-mounting screws and washers **3**.
    - 2) Remove the cover by lifting it up.

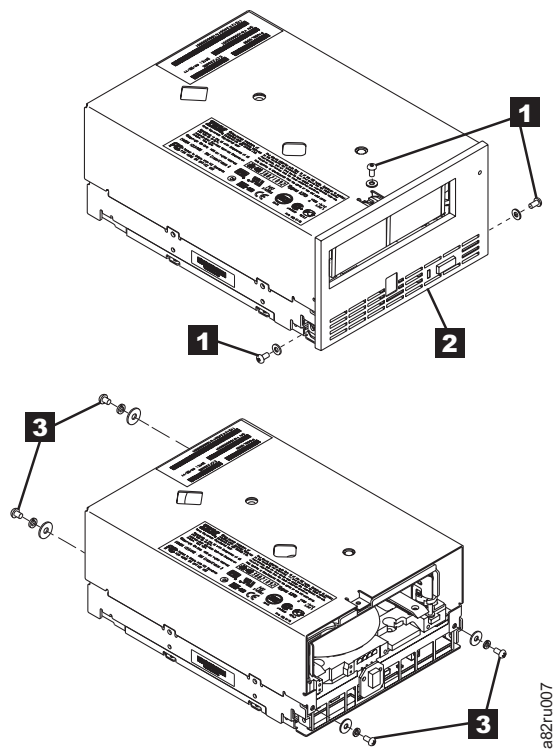


Figure 10. Removing the cover from the internal drive

- \_\_\_ Step 5. Inspect the drive to decide which of the following conditions most closely matches the symptom on the drive:
- **Tape spooled off the supply reel** - All the tape appears to be on the take up reel and no tape is on the supply reel (inside the cartridge). Test the drive after the procedure is completed.
  - **Tape pulled from leader pin (or broken at the front end)** - All the tape appears to be on the supply reel (inside the cartridge) and very little or no tape appears to be on the take up reel. The leader block is positioned in the take up reel. Return the drive after the procedure is completed.
  - **Tape broken in mid-tape** - Tape appears to be on both the supply reel (inside the cartridge) and take up reel. Test the drive after the procedure is completed.
  - **Tape tangled along tape path** - Tape appears to be tangled and damaged but in tact. Return the drive after the procedure is completed.
- OR --
- No damage to tape (or no apparent failure)** - There appears to be no damage or slack to the tape. Return the drive after the procedure is completed.

## Tape Spooled off Supply Reel

- \_\_\_ Step 1. With the front of the drive facing you, pull an arm's length of tape out of the take up reel from the left side of the drive.
- \_\_\_ Step 2. From the take up reel, thread tape around the rear of the tape path and over the head rollers on the left side of the drive.
- \_\_\_ Step 3. Set the drive on its left side with the head and tape path facing up.
- \_\_\_ Step 4. Moisten a cotton swab with water and wet approximately 13 mm (0.5 in.) of the tape end and feed it onto the supply reel (inside the cartridge).
- \_\_\_ Step 5. From the bottom of the drive, insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle.

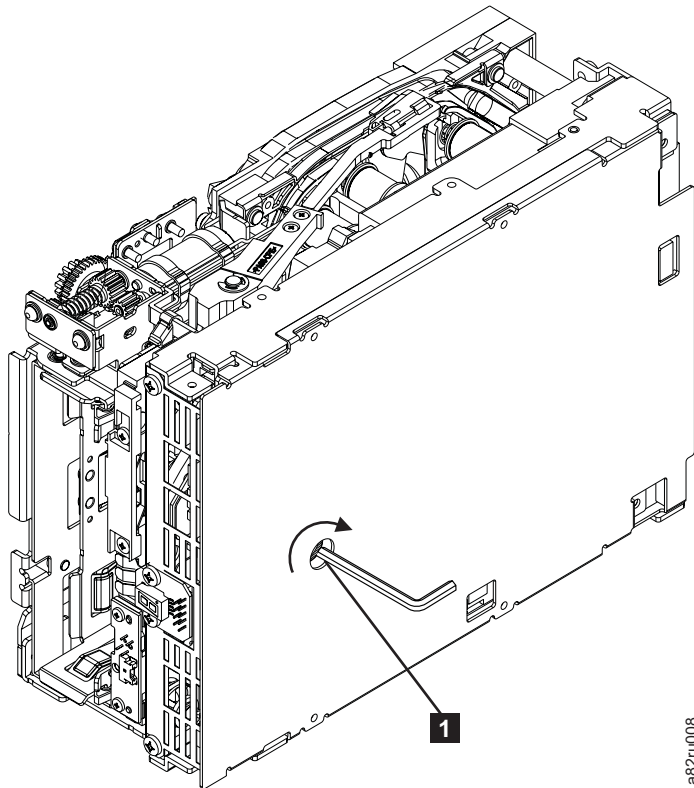


Figure 11. Using hex wrench to rewind tape into cartridge

- \_\_\_ Step 6. Turn the supply reel clockwise, allowing the moistened tape to adhere to the hub as it winds around the supply reel (inside the cartridge).
- \_\_\_ Step 7. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. Ensure that you do not stretch the tape.
- \_\_\_ Step 8. Reassemble the drive, reversing the steps in "Beginning Procedure" on page 53.
- \_\_\_ Step 9. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, the cartridge ejects automatically.
- \_\_\_ Step 10. Test the drive (see "Function Code 1: Run Drive Diagnostics" on page 23) to determine if it should be replaced.

## Tape Pulled from or Broken near Leader Pin

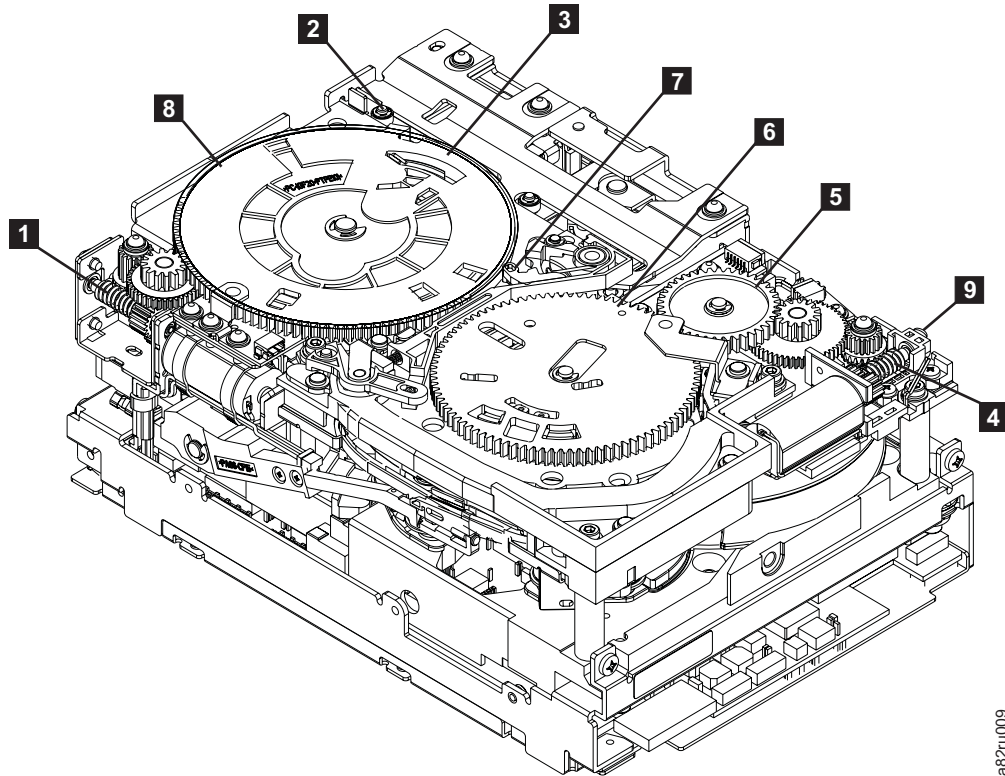


Figure 12. Drive with cover removed to reveal gear train.

<b>1</b>	Loader motor worm gear	<b>6</b>	Threader mechanism gear
<b>2</b>	Cartridge loader tray guide bearing	<b>7</b>	Lever
<b>3</b>	Rotator stub	<b>8</b>	Loader mechanism gear
<b>4</b>	Threader motor worm gear	<b>9</b>	Threader worm gear
<b>5</b>	Threader intermediate gear		

\_\_\_ Step 1. From the left side of the drive, pull out tape from the take up reel.

**Note:** If there is more than approximately 0.6 m (2 ft.) of tape on the take up reel, go to “Tape Broken in Mid-tape” on page 58.

\_\_\_ Step 2. If there is less than approximately 0.6 m (2 ft.) of tape on the take up reel, cut off the excess tape as close to the leader pin, as possible.

\_\_\_ Step 3. Locate the threader motor worm gear (**4** in Figure 12) the rear of the drive. You can either:

- Use your finger to rotate the threader motor worm gear and slowly rotate the threader mechanism gear (**6** in Figure 12) clockwise; or
- Use a #1 flathead screwdriver to turn the threader worm gear (**9** in Figure 12) clockwise.

This rotates the threader motor worm gear (**4** in Figure 12) clockwise, drawing the tape leader block assembly (LBA) into the cartridge.

- \_\_\_ Step 4. As the LBA is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear ( **4** in Figure 12 on page 56) stops. The LBA is in the correct position.

**Note:** Be sure to keep tension on the tape as the LBA is drawn into the cartridge by using a hex wrench as shown in Figure 11 on page 55.

- \_\_\_ Step 5. Notice the following:
- a. Loader mechanism gear ( **8** in Figure 12 on page 56) nearest the front of the drive that actuates the cartridge loader mechanism
  - b. Position of the rotator stub ( **3** in Figure 12 on page 56).
  - c. Front loader motor worm gear ( **1** in Figure 12 on page 56). Rotating this gear allows the loader mechanism gear ( **8** in Figure 12 on page 56) to turn.
- \_\_\_ Step 6. Rotate the loader motor worm gear ( **1** in Figure 12 on page 56) to turn the loader mechanism gear ( **6** in Figure 12 on page 56) counterclockwise. Continue turning until the rotator stub ( **3** in Figure 12 on page 56) loses contact with the lever ( **7** in Figure 12 on page 56). This releases the LBA leader pin.
- \_\_\_ Step 7. Rotate the threader motor worm gear ( **4** in Figure 12 on page 56) to turn the threader mechanism gear ( **6** in Figure 12 on page 56) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive ( **1** in Figure 13).

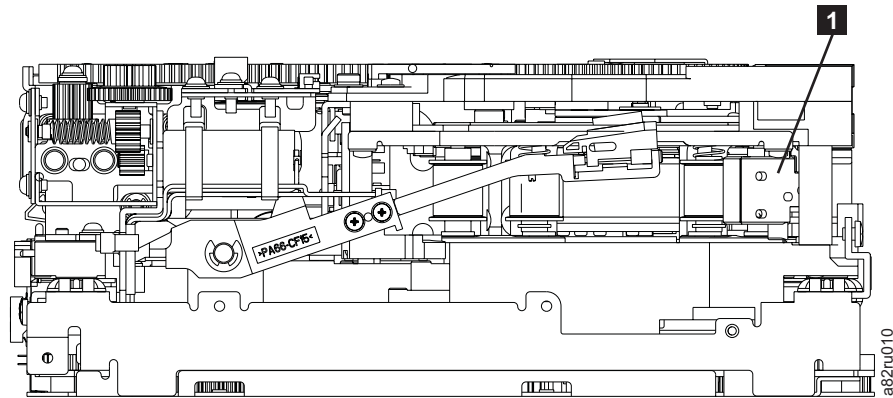


Figure 13. Leader Block Assembly (LBA)

- \_\_\_ Step 8. Continue rotating the loader motor worm gear ( **1** in Figure 12 on page 56) until the rotate stub ( **3** in Figure 12 on page 56) is positioned as shown. Notice that the rotator stub ( **3** in Figure 12 on page 56) is nearly aligned with the cartridge loader tray guide bearing ( **2** in Figure 12 on page 56).
- \_\_\_ Step 9. Remove the cartridge from the cartridge loader tray.
- \_\_\_ Step 10. Reassemble the drive by reversing the procedure in Step 4 on page 53 in Beginning Procedure.
- \_\_\_ Step 11. Refer to the appropriate procedure to install the new drive and return the failed drive.

## Tape Broken in Mid-tape

- \_\_\_ Step 1. With the front of the drive facing you, pull an arm's length of tape out of the take up reel from the left side of the drive.

**Note:** If there is less than approximately 5 cm (2 in.) of tape on the take up reel, go to "Tape Pulled from or Broken near Leader Pin" on page 56.

- \_\_\_ Step 2. From the supply reel inside the cartridge, pull approximately 0.3 m (1 ft.) of tape.
- \_\_\_ Step 3. From the take up reel, thread tape around the rear of the tape path and over the head rollers on the left side of the drive.
- \_\_\_ Step 4. Moisten a cotton swab with water, and wet approximately 13 mm (0.5 in.) of the tape end. Overlap the tape ends, loosely mending them together.
- \_\_\_ Step 5. Set the drive on its left side with the head and tape path facing up.
- \_\_\_ Step 6. From the bottom of the drive, locate the access hole ( **1** in Figure 14) in the bottom cover. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. begin spooling tape back into the cartridge by turning the hex wrench clockwise.

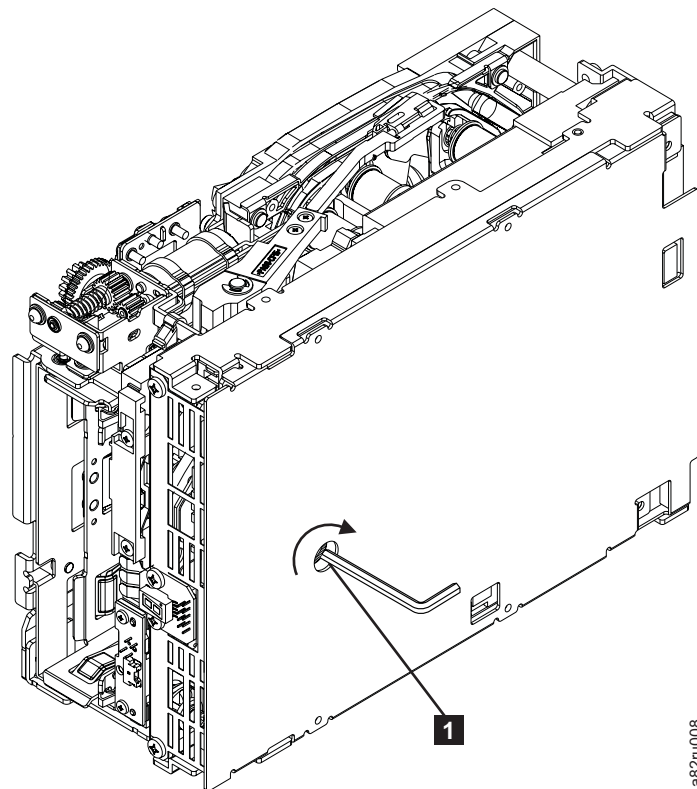


Figure 14. Using hex wrench to rewind tape into cartridge

- \_\_\_ Step 7. Turn the supply reel clockwise, carefully guiding the mended portion of the tape to wind around the hub of the supply reel located inside the cartridge. Continue spooling into the cartridge until the tape is taut. The tape must remain within the flanges of the tape guiding rollers. Ensure that you do not stretch the tape.

- \_\_\_ Step 8. Reassemble the drive by reversing the procedure in Step 4 on page 53 in Beginning Procedure.
- \_\_\_ Step 9. Allow the drive to perform mid-tape recovery. This takes several minutes. When this activity completes, the cartridge ejects automatically.
- \_\_\_ Step 10. Test the drive (see "Function Code 1: Run Drive Diagnostics" on page 23) to determine if it should be replaced.

## Tape Tangled along Tape Path

- \_\_\_ Step 1. Carefully pull out excess tape and untangle.

**Note:** If you find the tape to be broken, go to one of the following appropriate procedures:

- "Tape Spooled off Supply Reel" on page 55
- "Tape Pulled from or Broken near Leader Pin" on page 56

--OR--

"Tape Broken in Mid-tape" on page 58

- \_\_\_ Step 2. Set the drive on its left side with the head and tape path facing up.

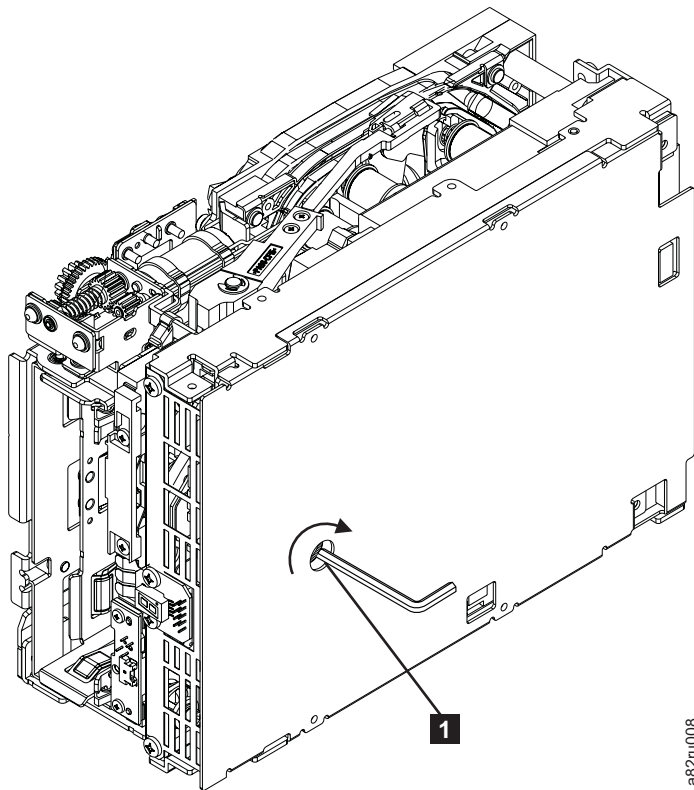


Figure 15. Using hex wrench to rewind tape into cartridge

- \_\_\_ Step 3. From the bottom of the drive, locate the access hole ( **1** in Figure 15).
- \_\_\_ Step 4. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. Begin spooling the tape back into the cartridge by turning the hex wrench clockwise.

- \_\_\_ Step 5. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. Ensure that you do not stretch the tape.
- \_\_\_ Step 6. Locate the threader motor worm gear ( **4** in Figure 16) on the rear of the drive. You can either:
  - a. Use your finger to rotate the threader motor worm gear and slowly rotate the threader mechanism gear ( **6** in Figure 16) clockwise;
  - OR
  - b. Use a #1 flathead screwdriver to turn the worm gear ( **9** in Figure 16) clockwise.

This rotates the threader motor worm gear ( **4** in Figure 16) clockwise, drawing the LBA into the cartridge.

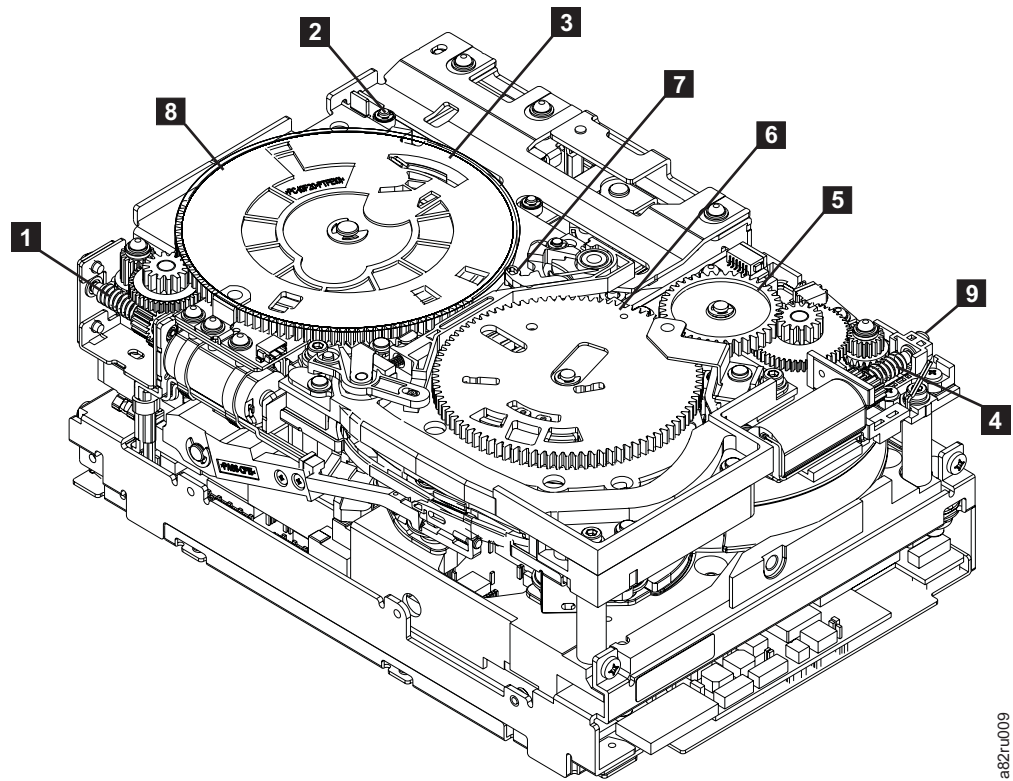


Figure 16. Drive with cover removed to reveal gear train.

<b>1</b>	Loader motor worm gear	<b>6</b>	Threader mechanism gear
<b>2</b>	Cartridge loader tray guide bearing	<b>7</b>	Lever
<b>3</b>	Rotator stub	<b>8</b>	Loader mechanism gear
<b>4</b>	Threader motor worm gear	<b>9</b>	Threader worm gear
<b>5</b>	Threader intermediate gear		

- \_\_\_ Step 7. As the tape leader block assembly (LBA) is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear ( **4** in Figure 16) stops. The LBA is in the correct position.



**Note:** Be sure to keep tension on the tape as the LBA is drawn into the cartridge by using a hex wrench as shown in Figure 15 on page 59.

- \_\_\_ Step 8. Notice the:
  - a. Loader mechanism gear ( **6** in Figure 16 on page 60) nearest the front of the drive that actuates the cartridge loader mechanism.
  - b. Position of the rotate stub ( **3** in Figure 16 on page 60).
  - c. Front loader motor worm gear ( **1** in Figure 16 on page 60). Rotating this gear allows the loader mechanism gear ( **8** in Figure 16 on page 60) to turn.
- \_\_\_ Step 9. Rotate the loader motor worm gear ( **1** in Figure 16 on page 60) to turn the threader mechanism gear ( **6** in Figure 16 on page 60) counterclockwise. Continue turning until the rotator stub ( **3** in Figure 16 on page 60) loses contact with the lever ( **7** in Figure 16 on page 60). This releases the LBA leader pin.
- \_\_\_ Step 10. Rotate the threader motor worm gear ( **4** in Figure 16 on page 60) to turn the threader mechanism gear ( **6** in Figure 16 on page 60) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive shown as **1** Figure 17.

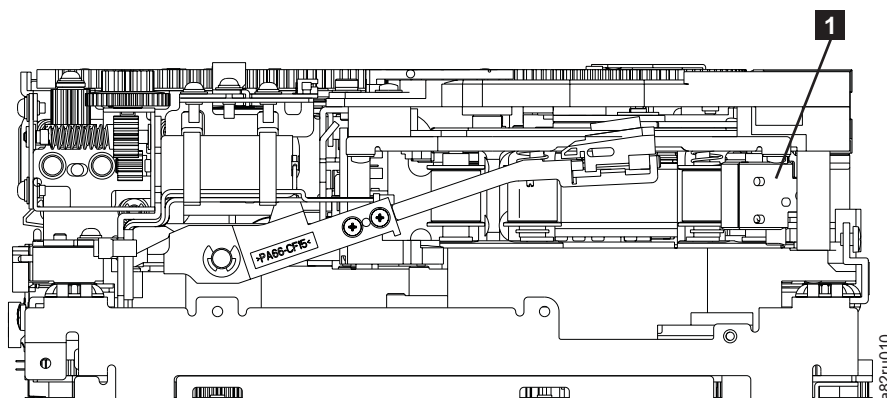
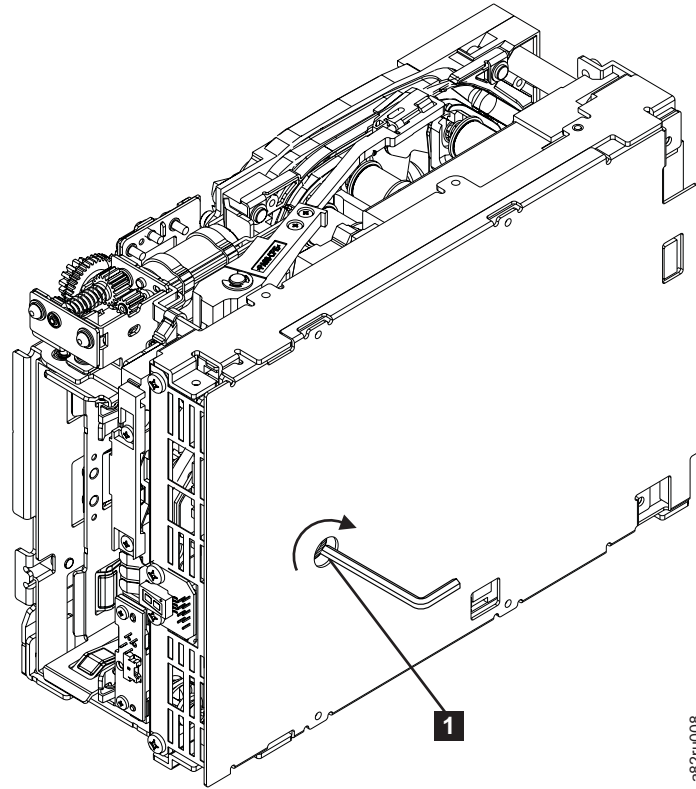


Figure 17. Leader Block Assembly (LBA)

- \_\_\_ Step 11. Continue rotating the loader motor worm gear ( **1** in Figure 16 on page 60) until the rotator stub ( **3** in Figure 16 on page 60) is positioned as shown. Notice that the rotator stub ( **3** in Figure 16 on page 60) is nearly aligned with the cartridge loader tray guide bearing ( **2** in Figure 16 on page 60).
- \_\_\_ Step 12. Remove the cartridge from the cartridge loader tray.
- \_\_\_ Step 13. Reassemble the drive by reversing the procedure in Step 4 on page 53 in Beginning Procedure.
- \_\_\_ Step 14. Refer to the appropriate procedure to install the new drive and return the failed drive.

## No Apparent Failure or Damage to Tape

- \_\_\_ Step 1. Set the drive on its left side with the head and tape path facing up.

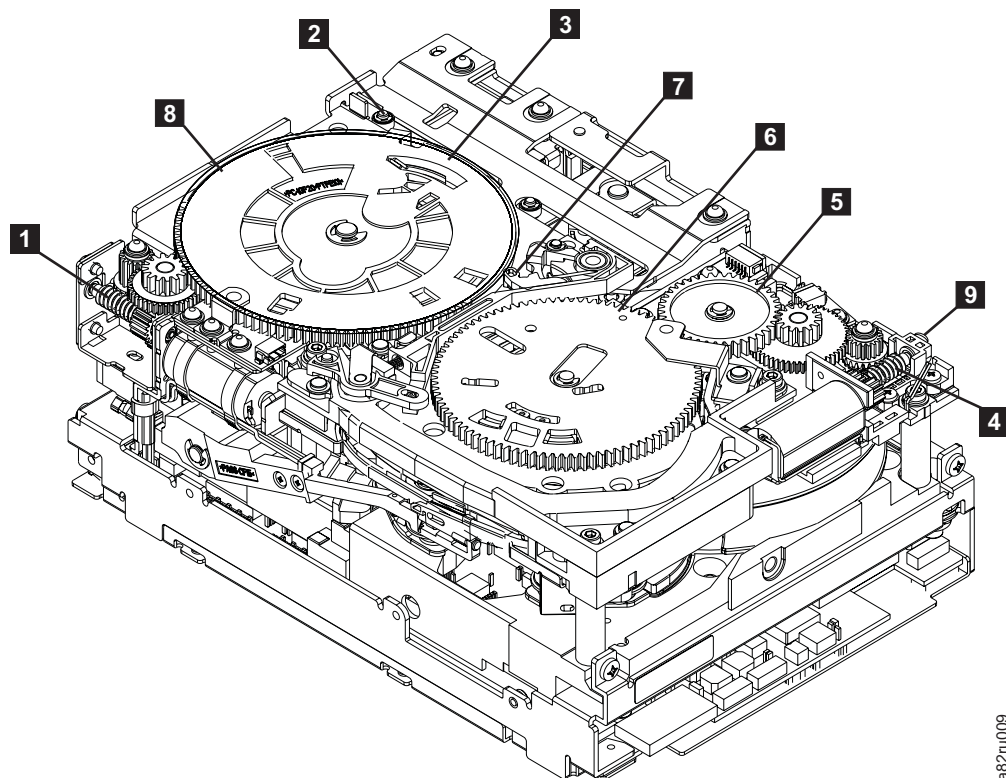


a82ru008

Figure 18. Using hex wrench to rewind tape into cartridge

- \_\_\_ Step 2. From the bottom of the drive, locate the access hole ( **1** in Figure 15 on page 59).
- \_\_\_ Step 3. Insert a 2.5 mm offset hex wrench through the bottom cover access hole and into the reel motor axle. Begin spooling the tape back into the cartridge by turning the hex wrench clockwise.
- \_\_\_ Step 4. Continue spooling into the cartridge until the tape is taut and remains within the flanges of the tape guiding rollers. Ensure that you do not stretch the tape.
- \_\_\_ Step 5. Locate the threader motor worm gear ( **4** in Figure 19 on page 63) on the rear of the drive. You can either:
  - a. Use your finger to rotate the threader motor worm gear and slowly rotate the threader mechanism gear ( **6** in Figure 19 on page 63) clockwise;
  - OR--
  - b. Use a #1 flathead screwdriver to turn the threader worm gear ( **9** in Figure 19 on page 63) clockwise.

This rotates the threader motor worm gear ( **4** in Figure 19 on page 63) clockwise, drawing the LBA into the cartridge.



a82u009

Figure 19. Drive with cover removed to reveal gear train.

<b>1</b>	Loader motor worm gear	<b>6</b>	Threader mechanism gear
<b>2</b>	Cartridge loader tray guide bearing	<b>7</b>	Lever
<b>3</b>	Rotator stub	<b>8</b>	Loader mechanism gear
<b>4</b>	Threader motor worm gear	<b>9</b>	Threader worm gear
<b>5</b>	Threader intermediate gear		

- \_\_\_ Step 6. As the tape leader block assembly (LBA) is secured in the cartridge, you should hear the LBA retention spring clips click into place. If you do not hear the click, continue rolling until the threader motor worm gear (**4** in Figure 16 on page 60) stops. The LBA is in the correct position.

**Note:** Be sure to keep tension on the tape as the LBA is drawn into the cartridge by using a hex wrench as shown in Figure 15 on page 59.

- \_\_\_ Step 7. Notice the:
- Loader mechanism gear (**6** in Figure 19) nearest the front of the drive that actuates the cartridge loader mechanism.
  - Position of the rotate stub (**3** in Figure 19).
  - Front loader motor worm gear (**1** in Figure 19). Rotating this gear allows the loader mechanism gear (**8** in Figure 19) to turn.
- \_\_\_ Step 8. Rotate the loader motor worm gear (**1** in Figure 19) to turn the threader mechanism gear (**6** in Figure 19) counterclockwise. Continue turning until the rotator stub (**3** in Figure 19) loses contact with the lever (**7** in Figure 19). This releases the LBA leader pin.

- \_\_\_ Step 9. Rotate the threader motor worm gear ( **4** in Figure 19 on page 63) to turn the threader mechanism gear ( **6** in Figure 19 on page 63) counterclockwise. This moves the LBA out of the cartridge and past the read/write head. Stop this rotation when the LBA is near the tape guide roller nearest the rear of the drive shown as **1** Figure 20.

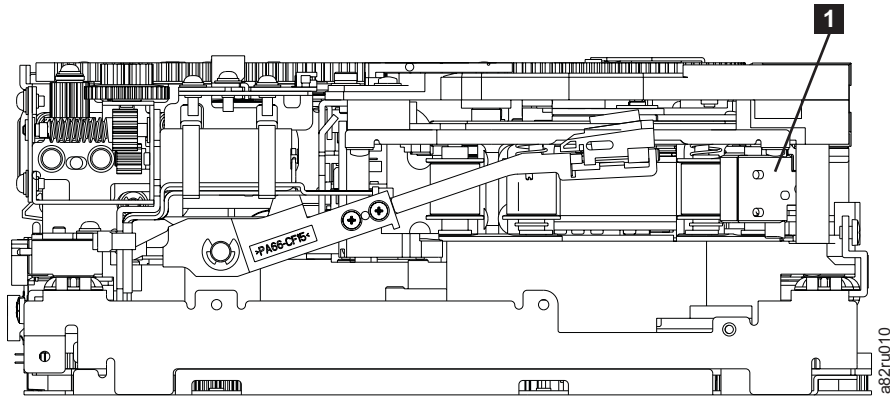


Figure 20. Leader Block Assembly (LBA)

- \_\_\_ Step 10. Continue rotating the loader motor worm gear ( **1** in Figure 19 on page 63) until the rotator stub ( **3** in Figure 19 on page 63) is positioned as shown. Notice that the rotator stub ( **3** in Figure 19 on page 63) is nearly aligned with the cartridge loader tray guide bearing ( **2** in Figure 19 on page 63).
- \_\_\_ Step 11. Remove the cartridge from the cartridge loader tray.
- \_\_\_ Step 12. Reassemble the drive by reversing the procedure in Step 4 on page 53 in Beginning Procedure.
- \_\_\_ Step 13. Refer to the appropriate procedure to install the new drive and return the failed drive.

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## Notices

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## Glossary

This glossary defines the special terms, abbreviations, and acronyms that are used in this publication.

## Numbers and Symbols

**2:1 compression.** The relationship between the quantity of data that can be stored with compression as compared to the quantity of data that can be stored without compression. In 2:1 compression, twice as much data can be stored with compression as can be stored without compression.

**μs.** Abbreviation for microsecond or one millionth of a second (.000001 s).

## A

**A.** See *ampere*.

**acclimation time.** Pertaining to the drive, the amount of time that is needed for the drive to adjust to change in temperature, altitude, climate, or environment.

**active.** The condition that the SCSI bus is in when a server is trying to use one or more devices on the bus.

**adapter.** See *adapter card*.

**adapter card.** A circuit board that adds function to a computer.

**AL\_PA.** See *Arbitrated Loop Physical Address*.

**amp.** See *ampere*.

**ampere (A, amp).** A unit of measure for electric current that is equivalent to a flow of one coulomb per second, or equivalent to the current produced by one volt applied across a resistance of one ohm.

**American National Standards Institute.** A private, non-profit organization that gathers and disseminates information about standards and conformity issues that affect the business, government, and people of the United States.

**ANSI.** See *American National Standards Institute*.

**autosense data.** Sent by the drive to the server, sense data that automatically accompanies a Check Condition in response to an error. The server does not need to send a REQUEST SENSE command to get the sense data. Autosense data is available only in the Fibre Channel version of the drive (Model T400F).

## B

**backhitch.** During tape movement (reading or writing), the condition that occurs when the tape drive must stop the tape, reverse it, and restart tape motion due to certain events. A backhitch usually occurs when the server's net (compressed) data rate is less than the drive's data rate.

**backreflection.** Pertaining to instances where light is launched into an optical fiber in a forward direction, the light that is returned to the launch point in the reverse direction.

**backups.** The short-term retention of records used for restoring essential business and server files when vital data has been lost because of program or server errors or malfunctions.

**backward compatible.** Capable of being used with a previous product that was designed for a similar purpose. For example, a tape cartridge that is designed to be used with a modern tape drive but can also be used with certain older tape drives. Synonymous with *downward compatible*.

**bar code.** A code that represents characters by sets of parallel bars of varying thickness and separation. The bars are read optically by transverse scanning.

**bar code label.** A slip of paper bearing a bar code and having an adhesive backing. The bar code label must be affixed to a tape cartridge to enable the library to identify the cartridge and its volume serial number.

**bezel.** The removable frame that fits over the front of the drive.

**bit.** The smallest unit of data in a computer. A bit (short for binary digit) has a single binary value (either 0 or 1). Computers store data and execute instructions in bit multiples called bytes. In most computer systems, there are eight bits in a byte.

**burst data transfer rate.** The maximum speed at which data is transferred.

**bus.** See *SCSI bus*.

**byte.** A string that consists of a certain number of bits (usually 8) which are treated as a unit and represent a character. A byte is a fundamental unit of data.

## C

**C.** See *Celsius*.

**capacity.** The amount of data that can be contained on storage media and expressed in bytes.

**cartridge.** See *tape cartridge*.

**cartridge door.** On a tape cartridge, the hinged barrier that can be opened to access, or closed to protect, the magnetic tape within the cartridge.

**cartridge manual rewind tool.** A device that can be fitted into the reel of a cartridge and used to rewind tape into or out of the cartridge.

**cartridge memory.** See *LTO cartridge memory*.

**Celsius.** Having a thermometric scale on which the interval between the freezing point and the boiling point of water is divided into 100 degrees, with 0° representing the freezing point and 100° representing the boiling point.

**channel calibration.** A feature of the drive by which it automatically customizes each read/write data channel to compensate for variations in such things as the recording channel's transfer function, the media, and characteristics of the drive head. Channel calibration optimizes system performance.

**circuit board.** A thin sheet on which chips and other electronic components are placed. Computers consist of one or more boards, often called cards or adapters.

**cleaning cartridge.** A tape cartridge that is used to clean the heads of a tape drive. Contrast with *data cartridge*.

**clockwise.** In the direction that the hands of a clock rotate, as viewed from the front.

**command time-out.** Following the issuance of a command, a period of time during which it is determined that there is a bad connection between the server and the drive.

**compression.** The process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks.

**configure.** To describe to a server the devices, optional features, and programs installed on the system.

**contiguous.** Touching along a boundary or at a point.

**core.** The light-conducting central portion of an optical fiber. The core is composed of material that has a higher index of refraction than the cladding (the material that surrounds the core).

**counterclockwise.** In a direction opposite to that in which the hands of a clock rotate, as viewed from the front.

**current.** The quantity of charge per unit of time. Current is measured in amperes.

**cycle power.** To apply and remove electrical power to a device within a short time span.

## D

**data.** Any representations such as characters or analog quantities to which meaning is, or might be, assigned.

**data cartridge.** A tape cartridge that is dedicated to storing data. Contrast with *cleaning cartridge*.

**data compression.** See *compression*.

**data transfer rate.** The average number of bits, characters, or blocks per unit of time that pass between corresponding equipment in a data transmission system. The rate is expressed in bits, characters, or blocks per second, minute, or hour.

**dc.** Direct current.

**degauss.** To make a magnetic tape nonmagnetic by exposing the tape to electrical coils which carry currents that neutralize the magnetism of the tape.

**device.** Any hardware component or peripheral, such as a tape drive or tape library, that can receive and send data.

**device driver.** A file that contains the firmware that is needed to use an attached device.

**diagnostic.** A software program that is designed to recognize, locate, and explain faults in equipment or errors in programs.

**diagnostic cartridge.** A tape cartridge that enables the detection and isolation of errors in programs and faults in equipment.

**direct current (dc).** An electric current flowing in one direction only and substantially constant in value.

**director-class switch.** A high-end switch that includes such qualities as fault tolerance, high throughput, high reliability, port density, and so forth.

**drive dump.** The recording, at a particular instant, of the contents of all or part of one storage device into another storage device, usually as a safeguard against faults or errors, or in connection with debugging.

**drive head.** The component that records an electrical signal onto magnetic tape, or reads a signal from tape into an electrical signal.

**drive sense data.** See *SCSI drive sense data*.

**dump.** See *drive dump*.

**duplex.** See *duplex transmission*.

**duplex adapter.** A mechanism that allows a device to send and receive communication at the same time.



**duplex transmission.** Transmission in both directions, either one direction at a time (half-duplex) or both directions simultaneously (full-duplex).

## E

**eject.** To remove or force out from within.

**electronic mail.** Correspondence in the form of messages transmitted between user terminals over a computer network.

**e-mail.** See *electronic mail*.

**enclosure.** A device, such as a desktop unit, tape cartridge autoloader, or tape library, into which you can install the drive.

**error log.** Maintained by the drive, a list that contains the ten most recent error codes. The codes identify errors that pertain to the drive.

## F

**feature switch.** Located under the drive, a bank of eight micro switches that can be manually toggled on or off to activate or deactivate different characteristics of the drive.

**fiber optic cable.** The medium by which light is transmitted through fibers or thin rods of glass or some other transparent material of high refractive index.

**fiber optics.** A branch of optics dealing with the transmission of light through fibers or thin rods of glass or some other transparent material of high refractive index.

**field microcode replacement tape.** A tape cartridge that contains new or revised firmware (microcode) for the drive.

**file.** A named set of records that are stored or processed as a unit.

**filemark.** Located on the magnetic tape within a tape cartridge, a recorded element that typically marks the organizational boundaries in a serial file structure (such as directory boundaries) and that is requested to be written or read by the server.

**firmware.** The proprietary code that is usually delivered as part of an operating system. Firmware is more efficient than software that is loaded from an alterable medium, and is more adaptable to change than pure hardware circuitry. An example of firmware is the Basic Input/Output System (BIOS) in read-only memory (ROM) on a PC motherboard.

**FMR tape.** See *field microcode replacement tape*.

**foot.** A unit of length comprising 12 inches.

## G

**Gb.** See *gigabit*.

**GB.** See *gigabyte*.

**Generation 1.** The informal name for the IBM Ultrium Internal Tape Drive, which is the predecessor of the drive (Generation 2). The Generation 1 drive has a native storage capacity of up to 100 GB per cartridge and a native sustained data transfer rate of 15 MB per second.

**Generation 2.** The informal name for the drive, which is the second-generation version of the IBM Ultrium Internal Tape Drive (Generation 1). The Generation 2 drive has a native storage capacity of up to 200 GB per cartridge and a native sustained data transfer rate of 35 MB per second.

| **Generation 3.** The informal name for the Ultrium LTO  
| 3 Tape Drive. The Generation 3 drive has a native  
| storage capacity of up to 400 GB per cartridge and a  
| native data transfer rate of up to 80 MB per second.

**gigabit (Gb).** 1 000 000 000 bits. 1 Gb equals 100 MB.

**gigabyte (GB).** 1 000 000 000 bytes.

**ground.** An object that makes an electrical connection with the earth.

## H

**hard addressing.** Pertaining to the Fibre Channel drive (Model T400F), a method that identifies the drive's LID and, consequently, its AL\_PA (the AL\_PA enables the drive to communicate with other devices).

**hardware.** The physical equipment or devices that form a computer.

**head.** See *drive head*.

**Head Resistance Measurements test.** Part of the Test Head diagnostic, a procedure that determines whether the tape drive's head works correctly. The test measures the head's ability to withstand cracks and other defects.

**host.** The controlling or highest-level system in a data communication configuration. Synonymous with *server*.

**hot-pluggable.** Pertaining to the drive, the ability to remove the drive from an enclosure while the enclosure is powered-on.

**hub.** A communications device to which nodes on a multi-point bus or loop are physically connected. Hubs are commonly used in Fibre Channel networks to improve the manageability of physical cables. They maintain the logical loop topology of the network of which they are a part, while creating a "hub and

spoke” physical star layout. Unlike switches, hubs do not aggregate bandwidth. They typically support the addition or removal of nodes from the bus while it is operating.

## I

**ID.** Identifier.

**in.** See *inch*.

**inch.** A unit of length equal to 1/36 yard or 25.4 mm.

**initiator.** In SCSI terms, a SCSI device that requests an I/O process to be performed by another SCSI device (a target). In many cases, an initiator can also be a target.

**input/output (I/O).** Data that is provided to a computer or data that results from computer processing.

**insertion guide.** On the surface of the IBM LTO Ultrium Tape Cartridge, a large, notched area that prevents you from inserting the cartridge incorrectly.

**install.** (1) To set up for use or service. (2) The act of adding a product, feature, or function to a server or device either by a singular change or by the addition of multiple components or devices.

**Internet.** The worldwide collection of interconnected networks that use the Internet suite of protocols and permit public access.

**interposer.** An adapter-like device that allows a connector of one size and style to connect to a mating connector of a different size and style. Data provided to the computer or data resulting from computer processing.

**I/O.** See *input/output*.

## J

**J2 connector.** Located at the rear of the drive, the connector for the LDI (or RS-422) interface.

**J33 connector.** Located at the rear of the drive, a single connector that contains the connections for the SCSI signals and grounds, SCSI ID, SCSI bus termination, and drive power.

**jumper.** (1) A tiny connector that fits over a pair of protruding pins in a connector. A jumper can be moved to change electrical connectors. When in place, the jumper connects the pins electrically. (2) To place a jumper on a connector pin.

## L

**label.** A slip of paper with an adhesive backing that can be written on and affixed to a tape cartridge as a means of identification or description.

**label area.** On the LTO Ultrium Tape Cartridge, a recessed area next to the write-protect switch where a bar code label must be affixed.

**LAN.** See *local area network*.

**LDI.** See *Library/Drive Interface*.

**leader-pin block.** Located within the drive, the part that engages the steel pin which is attached to the tape in an LTO Ultrium Tape Cartridge. Once engaged, the leader-pin block pulls the tape from the cartridge into the drive.

**leader pin.** On the LTO Ultrium Tape Cartridge, a small metal column that is attached to the end of the magnetic tape. During tape processing the leader pin is grasped by a threading mechanism, which pulls the pin and the tape out of the cartridge, across the drive head, and onto a takeup reel. The head can then read or write data from or to the tape.

**LED.** See *light-emitting diode*.

**Library/Drive Interface.** An electrical interface standard that is approved by the Electronic Industries Association (EIA) for connecting serial devices.

**Library/Drive Interface (LDI) connector.** Located at the rear of the drive, the connector to which the internal LDI cable of an enclosure connects. The connection enables serial devices to communicate with the drive.

**LID.** See *loop identifier*.

**LID/status connector.** See *loop identifier (LID)/status connector*.

**link services.** The speed and topology of your Fibre Channel drive. If you choose not to alter the link services, the drive defaults to a negotiated speed and operation in an FC-AL topology with a direct connection to the server.

**LIP.** See *loop initialization protocol*.

**light-emitting diode (LED).** A semiconductor diode that emits light when subjected to an applied voltage and that is used in an electronic display.

**Linear Tape-Open (LTO).** A type of tape storage technology developed by the IBM Corporation, Hewlett-Packard, and Seagate. LTO technology is an “open format” technology, which means that its users have multiple sources of product and media. The “open” nature of LTO technology enables compatibility

between different vendors' offerings by ensuring that vendors comply with verification standards.

**load.** Following the insertion of a tape cartridge into the tape load compartment, the act of positioning the tape (performed by the tape drive) for reading or writing by the drive's head.

**load and unload cycle.** The act of inserting a cartridge into a tape drive, loading the tape to load point, rewinding the tape into the cartridge, and ejecting the cartridge from the drive.

**local area network (LAN).** A computer network that is located on a user's premises within a limited geographical area. The network consists of a set of devices that are connected to one another for communication and that can be connected to a larger network. Communications are limited to a moderate-sized geographic area (1 to 10 km) such as a single office building, warehouse, or campus.

**log sense data.** See *SCSI log sense data*.

**loop.** (1) A series of instructions that is repeated until a terminating condition is reached. (2) To connect so as to complete a loop.

**loss.** In fiber optics technology, the amount of a signal's power (expressed in dB) that is lost in connectors, splices, or fiber defects.

**Low Voltage Differential (LVD).** A low-noise, low-power, and low-amplitude electrical signaling system that enables data communication between a supported server and the drive. LVD signaling uses two wires to drive one signal over copper wire. The use of wire pairs reduces electrical noise and crosstalk.

**LTO.** See *Linear Tape-Open*.

**LTO cartridge memory (LTO-CM).** Within each LTO Ultrium Data Cartridge, an embedded electronics and interface module that can store and retrieve a cartridge's historical usage and other information.

**LTO-CM.** See *LTO cartridge memory*.

**LTO-DC.** See *LTO Data Compression*.

**LTO Data Compression (LTO-DC).** A method that compresses a server's data before the drive writes it to tape. LTO-DC detects but does not recompress or test record boundaries and file markers (which are encoded as control symbols). It also allows switching between compression and no compression within the data stream, which prevents data from expanding when the drive compresses random or encrypted data.

**LVD.** See *Low Voltage Differential*.

## M

**m.** See *meter*.

**magnetic tape.** A tape with a magnetizable surface layer on which data can be stored by magnetic recording.

**maintenance mode.** The state of operation in which the drive must be before it can run diagnostics, verify write and read operations, verify a suspect tape cartridge, update its own firmware, and perform other diagnostic and maintenance functions.

**MB.** See *megabyte*.

**media.** The plural of *medium*.

**media capacity.** See *capacity*.

**medium.** A physical material in or on which data may be represented, such as magnetic tape.

**megabyte (MB).** 1 000 000 bytes.

**metal particle tape.** In the LTO Ultrium Tape Cartridge, tape that uses very small, pure metal particles (rather than oxide coatings) in the magnetic layer.

**meter.** In the Metric System, the basic unit of length; equal to approximately 39.37 inches.

**micrometer.** One millionth of a meter (.000001 m). Synonymous with *micron*. Abbreviated as  $\mu\text{m}$ .

**micron.** One millionth of a meter (.000001 m). Synonymous with *micrometer*. Abbreviated as  $\mu\text{m}$ .

**microsecond.** One millionth of a second (.000001 s). Abbreviated as  $\mu\text{s}$ .

**millimeter (mm).** One thousandth of a meter (.001 m).

**millisecond (ms).** One thousandth of a second (.001 s).

**mm.** See *millimeter*.

**ms.** See *millisecond*.

**multimode fiber.** An optical fiber that has a core that is large enough to propagate more than one electromagnetic wave of light. The typical diameter is 62.5 micrometers.

## N

**N/A.** Not applicable.

**native storage capacity.** The amount of data that can be stored without compression on a tape cartridge.

**native sustained data transfer rate.** See *data transfer rate*.

**negotiated speed.** Defined by Fibre Channel Standards, the algorithm that ensures the highest speed that is supported by both the drive and the port to which it attaches. This negotiation occurs at power up and whenever a catastrophic link event occurs, such as a cable pull that exceeds the timeouts that are specified in the Standards. The speed is negotiated when the first possibility of a new connection (for example, a fiber cable) is established, and is maintained until the Fibre Channel connection is terminated. The speed is not renegotiated when a new device is attached to a loop.

**network.** A configuration of data processing devices and software that is connected for information interchange.

**network server.** In a local area network, a personal computer that provides access to files for all of the workstations in the network.

**ntutil.** Created by IBM, a utility program for LTO devices that connect to Windows NT® and Windows® 2000. *ntutil* provides problem determination for hardware or connections, assists with device and medium changer recognition, forces dumps, loads new firmware, sends and receives SCSI commands to and from the hardware, and obtains SCSI sense data to use in resolving errors.

**NVRAM.** Non Volatile Random Access Memory.

## O

**oersted.** The unit of magnetic field strength in the unrationalized centimeter-gram-second (cgs) electromagnetic system. The oersted is the magnetic field strength in the interior of an elongated, uniformly wound solenoid that is excited with a linear current density in its winding of one abampere per  $4\pi$  centimeters of axial length.

**offline.** The operating condition that the drive is in when the server's applications cannot interact with it.

**online.** The operating condition that the drive is in when the server's applications can interact with it.

**Open Systems.** Computer systems whose standards are not proprietary.

**operating environment.** The temperature, relative humidity rate, and wet bulb temperature of the room in which the drive routinely conducts processing.

**operating system.** The master computer control program that translates the user's commands and allows software application programs to interact with the computer's hardware.

**optical transceiver.** A device that both transmits and receives analog or digital signals over a light source.

## P

**panic reset.** The act of pressing and holding the Unload Button for 10 seconds to force a reset of a nonresponsive drive.

**parity.** The state of being even-numbered or odd-numbered. A parity bit is a binary number that is added to a group of binary numbers to make the sum of that group always odd (odd parity) or even (even parity).

**parity error.** A transmission error that occurs when the received data does not have the parity that is expected by the receiving system. This usually occurs when the sending and receiving systems have different parity settings.

**point-to-point connection.** Pertaining to data transmission between two locations without the use of any intermediate display station or computer.

**port.** (1) A system or network access point for data entry or exit. (2) A connector on a device to which cables for other devices such as display stations and printers are attached. (3) The representation of a physical connection to hardware. A port is sometimes referred to as an adapter; however, there can be more than one port on an adapter.

**power connector.** Located at the rear of the drive, the connector to which the internal power cable of an enclosure connects.

**power cord.** A cable that connects a device to a source of electrical power.

**power-off.** To remove electrical power from a device.

**power-on, powered-on.** (1) To apply electrical power to a device. (2) The state of a device when power has been applied to it.

**private device.** A device that is attached directly to a server and is not connected to a fabric or switch. A private device can be part of an arbitrated loop topology or point-to-point topology.

**protocol.** The meanings of, and the sequencing rules for, requests and responses that are used to manage a network, transfer data, and synchronize the states of network components.

**public device.** A device that is attached to a fabric or switch, and can communicate to that fabric or switch. A public device can be part of an arbitrated loop topology or point-to-point topology.

## Q

**quiesce.** To put a device into a temporarily inactive or inhibited state, but not remove it from the server.

## R

**read.** To acquire or interpret data from a storage device, from a data medium, or from another source.

**reboot.** To reinitialize the execution of a program by repeating the initial program load (IPL) operation.

**record.** The smallest distinct set of data bytes that is supplied from a server for processing and recording by a tape drive, and the smallest distinct set of data to be read from tape, reprocessed, and made available to a server by a tape drive.

**record boundaries.** The fixed limits of a record.

**relative humidity.** The ratio of the amount of water vapor actually present in the air to the greatest amount possible at the same temperature.

**repeater.** A device that regenerates signals to extend the range of transmission between data stations or to interconnect two branches. A repeater is a node of a local area network.

**reset.** To return a device or circuit to a clear state.

**LDI wrap plug.** A connector mechanism that connects to an LDI port for the purpose of testing the drive's circuitry for the LDI interface.

**LDI wrap test.** A diagnostic that can be run on the drive to determine whether the circuitry functions properly to and from the LDI connector.

## S

**s.** See *second*.

**SAN.** See *Storage Area Network*.

**SAN Data Gateway.** A device that provides Fibre Channel attachment between Open Systems servers and SCSI disk and tape storage systems.

**SC.** See *subscription channel connector*.

**scratch cartridge.** A data cartridge that contains no useful data, but can be written to with new data.

**SCSI.** See *Small Computer Systems Interface*.

**SCSI bus.** (1) A collection of wires through which data is transmitted from one part of a computer to another. (2) A generic term that refers to the complete set of signals that define the activity of the Small Computer Systems Interface (SCSI).

**SCSI connector.** Located at the rear of the drive, the connector that facilitates commands to and from the server, and to which the internal SCSI cable of an enclosure connects.

**SCSI device.** Anything that can connect into the SCSI bus and actively participate in bus activity.

**SCSI drive sense data.** In response to inquiry from the server about an error condition, a packet of SCSI sense bytes that contains information about the error and that is sent back to the server by the drive.

**SCSI ID.** The unique address (from 1 to 15) that you assign to an drive that uses a SCSI interface (Model T400).

**SCSI ID connector.** Located at the rear of the drive, the connector that enables the drive's SCSI address to be set. Addresses are determined by the placement of jumpers on the pins.

**SCSI interface.** See *Small Computer Systems Interface*.

**SCSI protocol.** A set of rules that control the communication and transfer of data between two or more SCSI devices or systems in a communications network.

**SCSI ID switch.** Located on an enclosure that contains a drive, a mechanism that connects to the drive and allows you to change the drive's SCSI ID without using jumpers.

**SCSI log sense data.** In response to inquiry from the server about the drive's error logs and counters, a packet of SCSI sense bytes which contains that information and which is sent back to the server by the drive. Log sense data is used to diagnose problems, especially if the problems are intermittent.

**SCSI wrap plug.** A connector mechanism that connects to a SCSI port for the purpose of testing the drive's circuitry for the SCSI interface.

**SCSI wrap test.** A diagnostic that can be run on the drive to determine whether the circuitry functions properly to and from the SCSI connector.

**second.** One sixtieth of a minute.

**selection time-out.** Following the selection of an option (for example, a data transfer), the period of time during which it is determined that there is a bad connection between the server and the drive.

**sense data.** Data that describes an I/O error. Sense data is presented to a server in response to a Sense I/O command.

**serial interface.** An interface that sequentially or consecutively executes two or more operations in a single device, such as an arithmetic and logic operation.

**server.** A functional unit that provides services to one or more clients over a network. Examples include a file server, a print server, or a mail server. The IBM @server pSeries®, IBM @server iSeries™, HP, and Sun are servers. Synonymous with *host*.



**ship group.** The group of supplies, cords, or documentation that is shipped with the drive.

**shipping environment.** The temperature, relative humidity rate, and wet bulb temperature of the environment to which the drive is exposed when it is transferred from one location to another.

**short-wave cable.** In Fibre Channel technology, a laser cable that uses a wavelength of 780 nanometers and is only compatible with multimode fiber.

**single-character display.** Located at the front of the drive, an LED that presents an alphabetical or numeric code which represents a diagnostic or maintenance function, error condition, or informational message.

**sleep mode.** A power-management function that causes the drive's electronics to automatically enter a low-power mode by which to conserve energy.

**Small Computer Systems Interface (SCSI).** A standard used by computer manufacturers for attaching peripheral devices (such as tape drives, hard disks, CD-ROM players, printers, and scanners) to computers (servers). Pronounced "scuzzy." Variations of the SCSI interface provide for faster data transmission rates than standard serial and parallel ports (up to 160 megabytes per second). The variations include:

- Fast/Wide SCSI: Uses a 16-bit bus, and supports data rates of up to 20 MBps.
- SCSI-1: Uses an 8-bit bus, and supports data rates of 4 MBps.
- SCSI-2: Same as SCSI-1, but uses a 50-pin connector instead of a 25-pin connector, and supports multiple devices.
- Ultra SCSI: Uses an 8- or 16-bit bus, and supports data rates of 20 or 40 MBps.
- Ultra2 SCSI: Uses an 8- or 16-bit bus and supports data rates of 40 or 80 MBps.
- Ultra3 SCSI: Uses a 16-bit bus and supports data rates of 80 or 160 MBps.
- Ultra160 SCSI: Uses a 16-bit bus and supports data rates of 160 MBps.

**soft addressing.** Pertaining to the Fibre Channel drive (Model T400F), a method that enables the drive to dynamically arbitrate its AL\_PA with other Fibre Channel devices on the loop. The AL\_PA enables the drive to communicate with other devices.

**software.** Programs, procedures, rules, and any associated documentation pertaining to the operation of a computer system.

**speed matching.** A technique used by the drive to dynamically adjust its native (uncompressed) data rate to the slower data rate of a server. Speed matching improves system performance and reduces backhitch.

**Status Light.** Located at the front of the drive, an LED that can be green or amber, and (when lit) solid or flashing. The condition of the light represents the state of the drive.

**Storage Area Network (SAN).** A high-speed subnetwork of shared storage devices. A SAN's architecture makes all storage devices available to all servers on a LAN or WAN. As more storage devices are added to a SAN, they too will be accessible from any server in the larger network. Because stored data does not reside directly on any of a network's servers, server power is used for business applications, and network capacity is released to the end user.

**storage environment.** The temperature, relative humidity rate, and wet bulb temperature of the environment in which the drive is nonoperational and is being kept for future use.

| **Tandberg Storage Solution 840LTO.** The version of  
| the Ultrium LTO 3 Tape Drive that uses the SCSI  
| interface.

**subscription channel connector (SC).** A push-pull type of optical connector that features high density, low loss, low backreflection, and low cost.

**switch.** A network infrastructure component to which multiple nodes attach. Unlike hubs, switches typically have the ability to switch node connections from one to another. A typical switch can facilitate several simultaneous bandwidth transmissions between different pairs of nodes.

## T

**TapeAlert.** A patented technology and ANSI standard that defines conditions and problems that are experienced by tape drives.

**TapeAlert flags.** Status and error messages that are generated by the TapeAlert utility and display on the server's console.

**tape cartridge.** A removable storage case that houses belt-driven magnetic tape that is wound on a supply reel and a takeup reel.

**tape path.** Within a tape drive, the channel in which the media moves.

**tapeutil.** Created by IBM, a utility program for LTO devices that connect to all supported servers except Windows NT and Windows 2000. *tapeutil* provides service aids for tape subsystems, offers a menu-driven tool for exercising or testing IBM tape and medium changer devices, and includes a command-line interface that is convenient for use in shell scripts.

**terminate.** To prevent unwanted electrical signal reflections by applying a device (known as a terminator) that absorbs the energy from the transmission line.

**terminator.** (1) A part that is used to end a SCSI bus. (2) A single-port, 75- $\Omega$  device that is used to absorb energy from a transmission line. Terminators prevent energy from reflecting back into a cable plant by absorbing the radio frequency signals. A terminator is usually shielded, which prevents unwanted signals from entering or valid signals from leaving the cable system.

**TERMPower.** Electrical power that is provided by a device (such as the drive) to a SCSI terminator so that the SCSI bus can function. To supply TERMPower, a jumper must be placed on pin 1 of the SCSI ID connector on the drive.

**Test Head diagnostic.** A test that determines whether the heads of the drive are operating properly and whether the drive can correctly read from and write to tape.

**throughput.** A measure of the amount of information that is transmitted over a network in a given period of time.

**topology.** In communications, the physical or logical arrangement of nodes in a network, especially the relationships among nodes and the links between them.

**track.** A linear or angled pattern of data that is written on a tape surface.

**transfer rate.** See *data transfer rate*.

## U

**Ultra160 LVD SCSI interface.** See *Small Computer Systems Interface*.

**uniform resource locator (URL).** The address of an item on the World Wide Web. It includes the protocol followed by the fully qualified domain name (sometimes called the host name) and the request. The web server typically maps the request portion of the URL to a path and file name.

**unload.** The act (performed by the drive) of unthreading tape from the drive's internal tape path and returning it (with the leader block) to the tape cartridge.

**Unload Button.** Located at the front of the drive, a push button that, when depressed, rewinds the tape in a cartridge and ejects the cartridge from the drive. The Unload Button can also be used to place the tape drive in maintenance mode, scroll through maintenance functions, exit maintenance mode, force a drive dump, and reset the drive.

**URL.** See *uniform resource locator*.

**utility.** See *utility program*.

**utility program.** A computer program that supports computer processes. For example, a diagnostic program, a trace program, or a sort program.

## V

**Vdc.** Volts dc (direct current).

**vital product data (VPD).** Information about a product. Among other details, the VPD may include a model number, serial number, part number, or level of firmware.

**volt.** The SI (international) unit of potential difference and electromotive force. Formally defined as the difference of electric potential between two points of a conductor that carries a constant current of one ampere when the power dissipated between these points is equal to one watt.

**VPD.** Vital product data.

## W

**W.** Watts.

**WAN.** See *wide area network*.

**watt.** The metric unit of power that is required to do work at the rate of one joule per second.

**web.** See *World Wide Web*.

**wet bulb temperature.** The temperature at which pure water must be evaporated adiabatically at constant pressure into a given sample of air in order to saturate the air under steady-state conditions. Wet bulb temperature is read from a wet bulb thermometer.

**wide area network (WAN).** A data communications network that is designed to serve an area of hundreds or thousands of miles (for example, national telephone networks).

**World Wide Web.** A network of servers that contain programs and files. Many of the files contain hypertext links to other documents that are available through the network.

**write.** To make a permanent or transient recording of data in a storage device or on a data medium.

**write protected.** Applicable to a tape cartridge, the condition that exists when some logical or physical mechanism prevents a device from writing on the tape in that cartridge.

**write-protect switch.** Located on the LTO Ultrium Tape Cartridge, a switch that prevents accidental

erasure of data. Pictures of a locked and unlocked padlock appear on the switch. When you slide the switch to the locked padlock, data cannot be written to the tape. When you slide the switch to the unlocked padlock, data can be written to the tape.

**Write/Read test.** Part of the Test Head diagnostic, a procedure that determines whether the drive can correctly read from and write to tape.



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